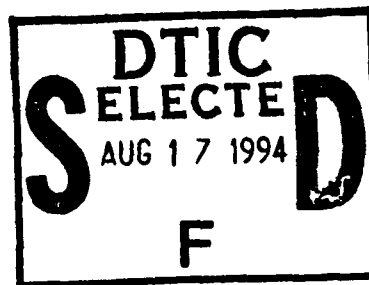AD-A283 496

Model Description and Proposed Application for the Enlisted Personnel Inventory, Cost, and Compensation Model

D. Alton Smith, Danny Eichers, Donald E. Rose, Jr., and David Rostker
Systems Research and Applications Corporation

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The Enlisted Personnel Inventory, Cost, and Compensation (EPICC) Model is a PC-based analysis tool that aids Army personnel planners in assessing the inventory and cost implications of changes in compensation and other personnel policies. The EPICC prototype was developed by SRA Corporation under a research and development effort sponsored by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). EPICC assists Army personnel planners in assessment of the cost and inventory implications of alternative Army-wide policies that may be under consideration. It is the ideal tool for this purpose because it is composed of three modules that touch on all aspects of personnel policy analysis: an inventory projection module, a compensation module, and a cost module. The inventory projection module is the core of EPICC. Using an analyst-defined scenario, which includes specifications of both compensation and personnel management policies, the module "ages" a baseline enlisted force for up to 9 fiscal years. Along with the projected inventories, the module estimates losses (normal, involuntary, and forced), reenlistments and extensions, promotions, and non-prior-service accession requirements.
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Director

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The compensation-reenlistment module uses the analyst's assumptions about military compensation and macroeconomic conditions over the projection period to adjust base-year reenlistment rates for changes in these factors. The adjusted rates are then used in the inventory projection module to age the force. The cost estimation module calculates the budget costs of the enlisted inventories projected in the inventory projection module. Because the cost estimation process is fully integrated with the inventory projections, little additional user effort is required to obtain cost information along with personnel counts. This adds an important dimension to the personnel policy analysis model, as different strategies for achieving a desired force structure can be easily evaluated on the basis of expected costs. The cost estimation methodology in the EPICC model is derived from the budget model in the Army Manpower Cost System (AMCOS).

EPICC provides the Army, for the first time, a single model in which inventory, cost estimation, and compensation-reenlistment modules are linked. The integration of these three personnel analysis tools in EPICC facilitates the complete evaluation of policy alternatives by eliminating the often difficult task of working with three different, and sometimes inconsistent, models and improves decision-making ability.

Model Description and Proposed Application for the Enlisted Personnel Inventory, Cost, and Compensation Model

D. Alton Smith, Danny Eichers, Donald E. Rose, Jr., and David Rostker

Systems Research and Applications Corporation

**Selection and Assignment Research Unit
Michael G. Rumsey, Chief**

**Manpower and Personnel Research Division
Zita M. Simutis, Director**

This report describes the development and application of a
PC-based manpower and personnel policy analysis model--the
Enlisted Personnel Inventory, Cost, and Compensation (EPICC)
model. This model serves as an easy-to-use, well-documented tool
for use by Army manpower analysts and decision-makers to project
the long-run effects of manpower policies and resource decisions
on the enlisted force. It does this by integrating the results
of existing research on the links between manpower compensation,
retention, and costs with an inventory projection capability. In
so doing it enhances the analyst's ability to capture the complex
interactions among a variety of policies and factors: compensa-
tion, promotion and separation, quality management, and external
factors (e.g., labor market conditions). As a PC-software tool,
EPICC can also serve as an effective device to orient and train
officers newly assigned to manpower and personnel analysis func-
tions. We are currently developing a set of training lessons for
those purposes.

EDGAR M. JOHNSON
Director

MODEL DESCRIPTION AND PROPOSED APPLICATION FOR THE ENLISTED PERSONNEL INVENTORY, COST, AND COMPENSATION MODEL

EXECUTIVE SUMMARY

Requirement:

The Enlisted Personnel Inventory, Cost, and Compensation (EPICC) model is a result of the need for an operational model available to policy makers that would evaluate the costs and benefits of the various manpower policy options, such as offering separation incentives, changes in tour length, and changes in promotion opportunity.

Evaluating numerous Army personnel policies has long been problematic because of second-order effects on the rest of the force. For example, increases in compensation or retirement benefits may increase retention, but if end-strength is held constant the higher retention reduces enlistment requirements and partially offsets the cost of higher benefits. If policy evaluations exclude such second-order effects, the results could be seriously flawed and lead to inefficient personnel policy decisions.

Procedures:

The work was divided into two phases. The first phase was composed of three parts: (1) the development of a conceptual design for EPICC, (2) the development of a cost data interface, and (3) the development of a prototype model to calibrate alternative policy scenarios at the all-Army level. The second phase modified the EPICC prototype to allow personnel policy analysts to model and evaluate separation incentives.

To drive the EPICC model, we collected baseline data from the Army's Enlisted Master File (EMF) for the period of May 1989 to May 1990, the most recent stable period prior to Desert Shield/Desert Storm and the force drawdown. The baseline rates consist of reenlistment,[1] extension, and non-ETS continuation rates that reflect the actual transactions occurring during that period. These rates were applied to a starting inventory of enlisted personnel that reflect the FY92 year end inventory. We also included those personnel policy parameters that were in effect in September 1992.

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[1]Reenlistment rates in EPICC define the behavior of soldiers facing a reenlistment decision, whether eligible or not. EPICC is unable to model reenlistment eligibility as defined by AR 601-280.

Findings:

The Enlisted Personnel Inventory, Cost, and Compensation (EPICC) model is a PC-based analysis tool that aids Army personnel planners in assessing the inventory and cost implications of changes in compensation and other personnel policies.

The inventory projection module is the core of EPICC. Using an analyst-defined scenario, which includes specifications of both compensation and personnel management policies, the module "ages" a baseline enlisted force for up to 9 fiscal years. Along with the projected inventories, the module estimates losses (normal, involuntary, and forced), reenlistments and extensions, promotions, and non-prior-service accession requirements.

The compensation-reenlistment module uses the analyst's assumptions about military compensation and macroeconomic conditions over the projection period to adjust base-year reenlistment rates for changes in these factors. The adjusted rates are then used in the inventory projection module to age the force.

The cost estimation module calculates the budget costs of the enlisted inventories projected in the inventory projection module. Because the cost estimation process is fully integrated with the inventory projections, little additional user effort is required to obtain cost information along with personnel counts. This adds an important dimension to the personnel policy analysis model, as different strategies for achieving a desired force structure can be easily evaluated on the basis of expected costs. The cost estimation methodology in the EPICC model is derived from the budget model in the Army Manpower Cost System (AMCOS).

Utilization of Findings:

EPICC assists Army personnel planners in their assessment of the cost and inventory implications of alternative Army-wide policies that may be under consideration. It is the ideal tool for this purpose because it is composed of three modules that touch on all aspects of personnel policy analysis.

1. Inventory projection. A personnel inventory is the stock of soldiers at a particular point in time, arrayed by key characteristics, such as grade or years of service. The inventory projection module predicts how that stock will change over time as individuals enter and leave the force under different Army-wide personnel policy scenarios. The inventory projection module can also be used to predict losses, determine accession requirements, and identify changes in the composition of the enlisted force.

2. Compensation-reenlistment link. Changes in military compensation affect reenlistment rates, which are the key input in assessing the year-to-year losses from an inventory. The compensation-reenlistment module provides the quantitative link

between compensation policy changes and reenlistment rates and controls for differences among demographic groups.

3. **Cost estimation**. Any change in personnel policies has cost as well as inventory implications. The cost estimation module determines the budget cost of a particular inventory by applying appropriate cost factors to the stocks and flows associated with the inventory.

EPICC provides the Army for the first time, a single model in which inventory, cost estimation, and compensation-reenlistment modules are linked. This advantage significantly improves decision-making because the analysis of multidimensional issues often requires the interaction of the three activities just described. Therefore, the integration of these three personnel analysis tools in EPICC facilitates the complete evaluation of policy alternatives by eliminating the often difficult task of working with three different, and sometimes inconsistent, models.

MODEL DESCRIPTION AND PROPOSED APPLICATION FOR THE ENLISTED PERSONNEL INVENTORY, COST, AND COMPENSATION MODEL

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MODEL DESCRIPTION AND PROPOSED APPLICATION FOR THE ENLISTED PERSONNEL INVENTORY, COST, AND COMPENSATION MODEL

INTRODUCTION

The Enlisted Personnel Inventory, Cost, and Compensation (EPICC) Model is a PC-based analysis tool that aids Army personnel planners in assessing the inventory and cost implications of changes in compensation and other personnel policies. The EPICC prototype was developed by SRA Corporation under a research and development effort sponsored by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). This report documents the construction of the initial prototype model. It addresses the conceptual framework, methodology, data requirements, and uses of the EPICC model.

In this introduction we describe the application for which EPICC could be used as a personnel policy analysis tool in the first section. The second section provides an overview of the model, describing the features of the model used in evaluating policy issues. The last section outlines the organization of the remainder of the report.

Application of EPICC

EPICC is a deterministic model by design. It assists Army personnel planners in their assessment of the cost and inventory implications of alternative policies that may be under consideration. It is the ideal tool for this purpose because it is composed of three modules that do the following:

1. <u>Inventory projection module.</u> As the name suggests, a personnel inventory is the stock of soldiers at a particular point in time, arrayed by key characteristics, such as grade or years of service. The inventory projection module is a Markov model that predicts how that stock will change over time as individuals enter and leave the force under different personnel policy scenarios. The inventory projection module can also be used to predict losses, determine accession requirements, and identify changes in the composition of the enlisted force.

2. <u>Cost estimation module.</u> Any change in personnel policies has cost as well as inventory implications. The cost estimation module determines the budget cost of a particular inventory by applying appropriate cost factors to the stocks and flows associated with the inventory.

3. <u>Compensation-reenlistment module.</u> Changes in military compensation affect reenlistment rates,[2] which are the key input

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[2]Reenlistment rates in EPICC define the behavior of soldiers facing a reenlistment decision, whether eligible or not. Since EPICC is unable to model reenlistment eligibility as defined by AR 601-280, we used the total population facing a reenlistment

in assessing the year-to-year losses from an inventory. The compensation-reenlistment module provides the quantitative link between compensation policy changes and reenlistment rates.

EPICC provides the Army for the first time, a single model in which inventory, cost estimation, and compensation-reenlistment modules are linked. This advantage significantly improves decision-making since the analysis of multi-dimensional issues often requires the interaction of the three activities described above. For example, in allocating the dollars available for Selective Reenlistment Bonuses (SRBs), the inventory module identifies projected mismatches between personnel and requirements for the next year. The compensation-reenlistment module shows the bonus increase needed to close personnel gaps in particular occupations, and the cost estimation module calculates whether a given allocation of bonuses will be within the total SRB budget. The integration of these three personnel analysis tools in EPICC facilitates the complete evaluation of policy alternatives by eliminating the often difficult task of working with three different, and sometimes inconsistent, models.
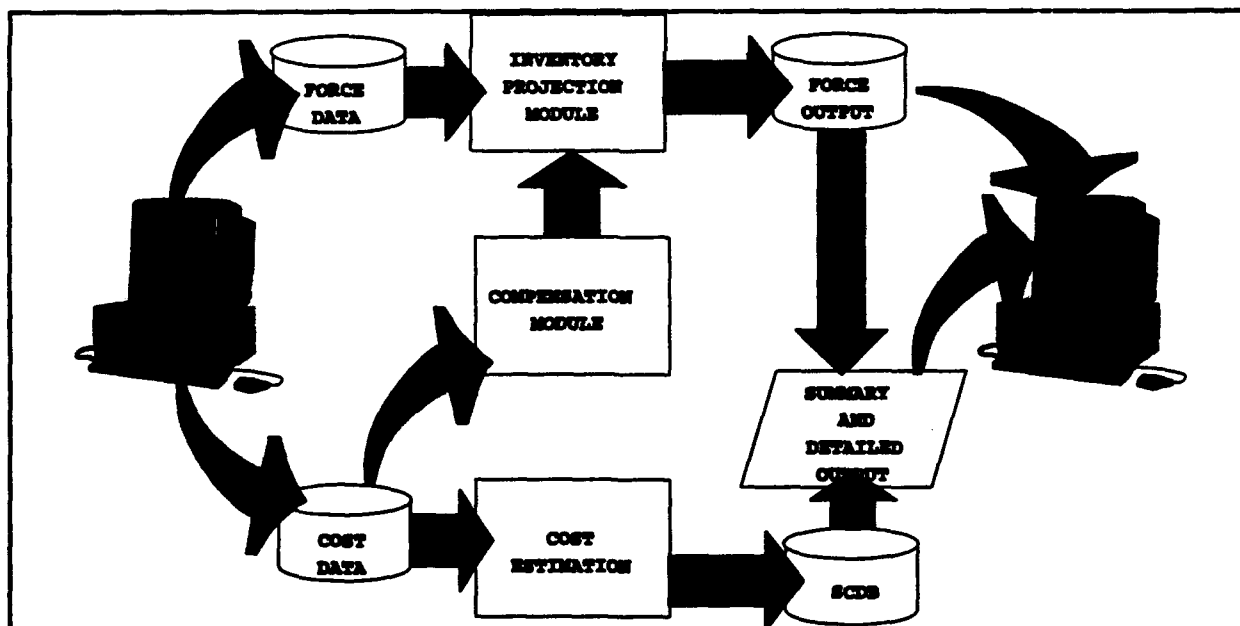
Figure 1 Figure 1. EPICC Model Schematic

Features of the EPICC Model

Figure 1 shows the key components of the prototype EPICC

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decision as the denominator in calculating rates.

model. In addition to the inventory, compensation-reenlistment, and cost estimation modules which contain the policy tools just discussed, the model includes a user interface which accepts the analyst's scenario assumptions and provides results in a variety of formats. A key feature of the user interface is the extensive use of menus and function keys along with a series of help screens to guide the user through the operation of the model. We outline the features of each of the modules in turn, starting with the core of EPICC, the inventory projection module.

Inventory Projection Module

Using a projection scenario defined by the analyst, this module "ages" the baseline enlisted force, determines accessions and promotions, and calculates summary measures describing the projected force. The inventory projection module includes the following features:

1. Inventories are dimensioned by both YOS and grade, providing views of the experience distribution of the force by both rank and time in service.

2. EPICC includes separate subinventories defined by gender, ethnic category (white and other), and quality. Quality is divided into six groups (AFQT category I-IIIA, IIIB, and IV, for high school diploma graduates and others). As noted above, disaggregating inventories allows force composition issues to be addressed by the model.

3. The inventory module produces annual projections over a nine-year horizon (current year, two budget years, and the six-year planning cycle).

4. Inventories are projected according to an endstrength constraint that is set by grade[3]; however, it determines NPS accessions utilizing user-specified distributions. For example, the model reflects the differences in how accessions are determined for high quality and other soldiers.

5. A time-to-ETS (Expiration of Term of Service) distribution which ages according to enlistment and reenlistment term assumptions is used to calculate the composite continuation rates in the model. As compared with using a static ETS distribution, this approach captures the inventory effects of policy changes affecting term lengths.

6. The rate used to convert accessions into first-year endstrength is calculated from attrition rates during the first year of service and assumptions about the quarterly timing of

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[3]Although currently disconnected, the model also has the capability to project inventories with the user specifying accession constraints. To activate this feature would require minor modifications.

accessions.

7.   Soldiers are initially promoted to fill vacancies, which
are determined as the difference between projected strengths and
requirements in a grade. This provides a link between the
manpower and personnel worlds as changes in requirements will
affect promotion rates. In addition the model accepts user
specified promotion rate floors and calculates the losses needed
to achieve the minimum promotion rates.

8.   EPICC accepts assumptions about involuntary losses and
models the implications of changing these policies, including
changes to retention control points, and increases or decreases
in the numbers of QMP losses that are expected to be boarded
out.[4]

9.   The inventory implications of early decision policies in
which soldiers are allowed to make reenlistment decisions before
the ETS point[5] can be modeled in EPICC.

10.   The analyst can directly modify the baseline
reenlistment, extension, and non ETS continuation rates. This
allows for the evaluation of policies not already programmed into
the model.

These features provide the personnel policy analyst with
greater projection accuracy and analysis flexibility. Projection
accuracy is improved through the use of procedures such as that
used to convert accession flows to a first year inventory stock.
Analysis flexibility is enhanced by allowing the user to change
as many of the assumptions that define a projection scenario as
possible. We believe that the EPICC inventory module, as
constructed, gives the analyst the ability to address a wider
variety of personnel issues than has previously been the case for
the Army enlisted force.

Compensation-Reenlistment Module

The compensation-reenlistment module uses the analyst's
assumptions about military compensation and macroeconomic
conditions over the projection period to predict how baseline
reenlistment rates will change in the future. These predicted
rates are then used in the inventory projection module to age the
enlisted force. The elements of military compensation that can
be specified by the EPICC user include:

1.   Annual increases in basic military pay, both force-wide

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[4]QMP losses might be expected to increase, say, if the Army
decides to raise the standards of quality for promotion to the
senior grades.

[5]This feature is currently disconnected, but can be
reactivated with minor modifications.

and targeted to YOS/grade groups;

2. Annual changes in allowances by pay grade, including BAQ, BAS, and VHA;

3. Annual SRB levels and the payment pattern by MOS; and

4. Several options for computing retirement benefits and other separation incentives.

In addition the analyst can specify annual changes for the two macroeconomic factors that affect enlisted retention, the level of civilian earnings and unemployment.

Reenlistment rates are adjusted for compensation assumptions using reenlistment models developed in the Army Compensation Models Project. The prototype for the compensation-reenlistment module is the Army Reenlistment Model (ARM), which predicts reenlistment rates for seven CMFs using assumptions similar to those defined above.

Cost Estimation Module

The cost estimation module in EPICC is based on AMCOS. Using the AMCOS data base and policy modules, the analyst specifies assumptions that determine how cost factors for the major cost elements are calculated. For example, assumptions about pay and allowance changes, in addition to affecting reenlistment rates and the inventories, automatically adjust the cost factors associated with annual compensation. Thus, as in AMCOS, the analyst can tailor the cost factors to suit a particular analysis rather than use historical data that is inappropriate. Features of the cost estimation module include:

1. **Accuracy and Completeness.** EPICC uses the Army's most up-to-date and comprehensive cost data, grounded in economic theory and institutional detail.

2. **User Flexibility.** The EPICC cost module permits user-defined scenarios, special case modification of cost factors, and tailored output.

The cost factors are applied against the appropriate flows and stocks derived from the inventory projection module. For example, using analyst-supplied assumptions about the quarterly distribution of accessions, promotions, and losses, the module calculates the manyears implied by the starting and ending inventories and multiplies these manyears by the compensation cost factors to determine the budget costs associated with military compensation.

Operation of EPICC

As required in the development contract, the prototype of the EPICC model operates on an AT-style microcomputer with a

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standard 640K of random access memory and a hard disk storage
device. The current EPICC prototype requires approximately 5
megabytes of disk storage space and, with a math coprocessor,
will be able to generate both inventory and cost projections for
a particular scenario in minutes. Run times will, of course, be
faster on more advanced microcomputers.

EPICC incorporates a number of features to make the model
straightforward to use, including:

1. <u>Menu-based operation.</u> The user will operate the model
through a system of menus, including those for defining
scenarios, choosing calculation options, and selecting output
formats.

2. <u>Default scenario assumptions.</u> As a result of the
flexibility of the model, there are many assumptions in a
projection scenario. EPICC comes complete with a full set of
default assumptions based on historical data. In most
applications the analyst will only have to change those
assumptions relevant to the issue being evaluated.

3. <u>Scenario editing.</u> To reduce obvious input errors, the
user interface checks assumptions on entry and, if necessary,
prompt the analyst for a new entry. Function keys are also used
to allow for speedy editing. For example, the user can apply a
single multiplier to groups of numbers, copy numbers from one
projection year to a range of projection years, and set a range
of rates to a single factor using function keys.

4. <u>Automatic file management.</u> Storage and retrieval of
scenario definition, baseline data, and results files are
invisible to the user.

5. <u>On-line help.</u> Help files accessible during program
operation provide on-line assistance to the user of EPICC. This
complements the written documentation that is provided with the
model.

Results from EPICC are provided to the analyst in a spreadsheet-
compatible form. This gives the analyst the flexibility to
perform additional calculations on the results using a
spreadsheet and graphics package of his or her choice.

Report Organization

The remainder of this report describes the EPICC model.
Chapters 2, 3, and 4 present the key components of the model, the
inventory projection module, the compensation-reenlistment link,
and the cost estimation module. For each module, we describe the
conceptual framework, the methodology used by the model, the list
of input variables required by the module, including both
baseline data and user assumptions, and the output variables
generated by the module. We describe, at the level of specific
equations, the calculations which convert the inputs to outputs.

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Chapter 5 discusses the technical aspects of the EPICC prototype, including hardware requirements, the user interface, and installation procedures. Chapter 6 presents the results of our model validation using an out of sample prediction for FY93. Chapter 7 is our conclusions. Appendix A discusses, in greater detail, the cost equations to include underlying variable definitions and data sources. Appendix B discusses the input data requirements for the inventory module to include data sources and extraction programs. Appendix C describes the design concept paper linking accession supply to the EPICC model.

Additional Documentation

In addition to on-line help screens, two companion reports provide additional information for the user / policy analyst: Eichers, D., Sola, M., McLernan, G., EPICC User's Manual, Systems Research and Applications Corporation, January 1994; and Eichers, D., EPICC Technical Documentation, Systems Research and Applications Corporation, January 1994.

INVENTORY PROJECTION MODULE

The inventory projection module is the core of the Enlisted Personnel Inventory Cost and Compensation Model. Using an analyst-defined scenario, which includes specifications of both compensation and personnel management policies, the module "ages" a baseline enlisted force for up to 9 fiscal years. Along with the projected inventories, the module estimates losses (normal, involuntary, and forced), reenlistments and extensions, promotions, and nonprior service accession requirements. This chapter describes the analytical design of the inventory projection module.

It is organized in three major sections. The first section describes the basic structure of the inventories in the module, the inventory "dimensions". The next section details the projection methodology by following the steps used to generate the results for each fiscal year. The final section summarizes the inputs to and outputs from the inventory projection module.

Inventory Dimensions

Each inventory in EPICC is an Army-wide inventory dimensioned by grade (8 columns -- E1-3, E4, E5, E6, E7, E8, E9, and a total) and years of service (31 rows -- YOS 0-1 through YOS 29-30+ and a total). Year of service and grade are the central characteristics of military personnel inventories, related to both the productivity and costs of a particular force.

For each fiscal year, the total enlisted inventory in EPICC is divided into "subinventories", which are defined by the *interaction* of the following characteristics:

1. __Ethnic Category.__ Because of the significant differences in continuation rates between white and other soldiers, we distinguish subinventories by these groupings, using the REDCAT designation on the EMF.

2. __Gender.__ Given the limitations on occupations open to women, it is important to include gender in the definition of the subinventories so that these restrictions can be reflected in inventory projections.

3. __Accession Quality.__ The quality composition of the enlisted force is of continuing policy interest. The EPICC subinventories have six quality categories defined by the interaction of AFQT (Category I-IIIA, IIIB, IV) and high school graduation status (diploma graduates, others).

An additional subinventory, including all soldiers for whom data on one or more of the above characteristics is missing, provides the correct roll-up to the total force. In total, then, there are 25 subinventories (2 ethnic groups x 2 gender groups x 6

quality groups + 1 missing) in EPICC.[6]

EPICC projects the enlisted force by summing the projections for this mutually exclusive and exhaustive set of subinventories. There are two reasons for accumulating the total inventory within an occupation from subinventories rather than directly projecting the total force. First, Army decision makers are often as interested in the composition of the force across these characteristics as in the total numbers. Second, starting with disaggregated projections will generally provide a more accurate projection of the total force. Retention research has demonstrated that both ETS and nonETS continuation rates vary significantly with soldier characteristics. To the extent that the composition of the enlisted force changes over the projection period, using continuation rates averaged across the baseline force composition will generate less accurate predictions than the disaggregated approach.

EPICC generates year-end inventories and associated statistics for a maximum of 9 projection years -- the current year, two budget years and a six-year planning (POM) cycle. The model accepts separate scenarios for each of the projection years so that the effects of a series of basic pay raises, for example, can be evaluated.[7] In the next section we describe the projection methodology.

Projection Methodology

Figure 2. provides an overview of the inventory projection methodology. Six major steps are required to estimate the inventory for each projection year.

1. The inventories from the previous year are decremented by involuntary losses from the Quality Management Program (QMP) and the application of retention control points (RCPs).

2. The continuing force is determined. Reenlistments, extensions, and normal losses are calculated in this step.

3. Prior service accessions are added to the inventory.

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[6] Disaggregation by military occupation would also be useful in some policy applications. Defining subinventories by both soldier characteristics and occupation, however, significantly increases the complexity of an inventory projection model, both from a computational and an analytical standpoint. See Smith et al., 1990, for a discussion of the design implications. The projection methodology implemented in EPICC, however, provides the foundation for this more general model.

[7]Some scenario assumptions are restricted to be the same in all projection years. These are noted in the description of the prediction methodology.

SCENARIO ASSUMPTIONS   **DATA INPUT**
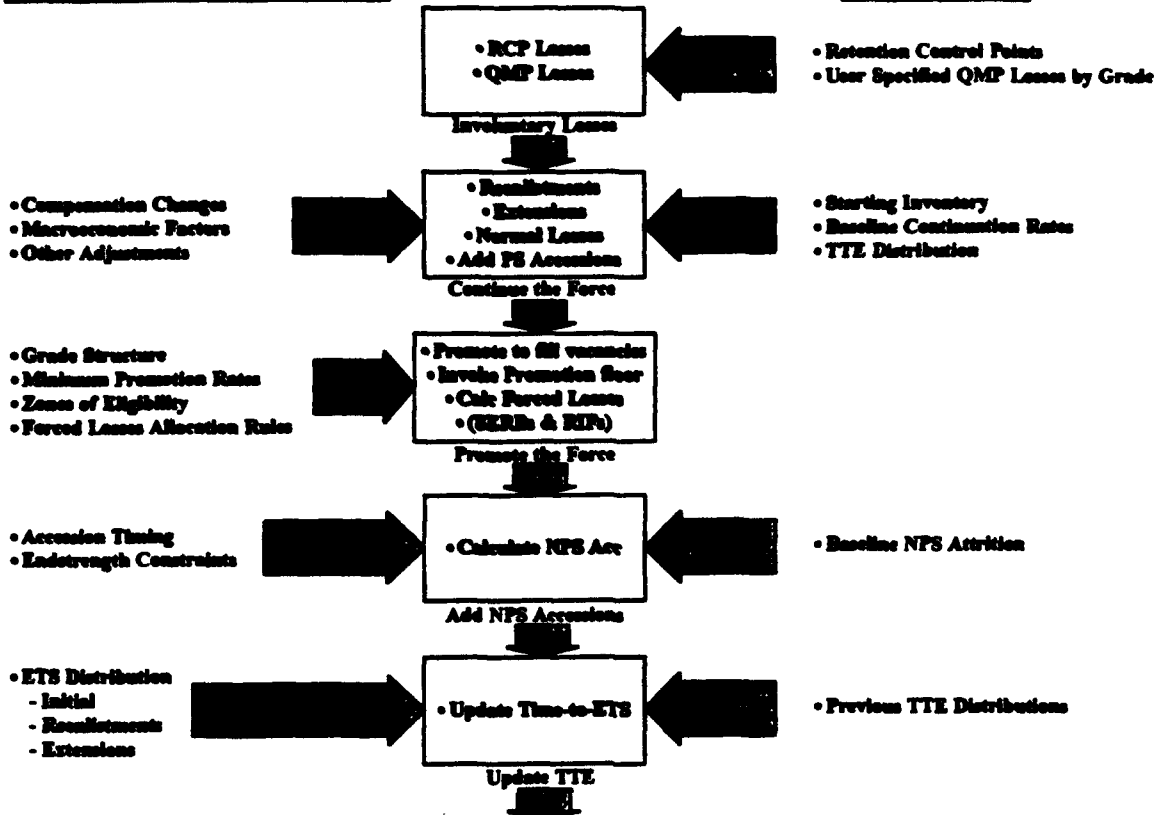
Figure 2.   Inventory Projection Steps

4.   The inventory is promoted to fill vacancies and meet
user-supplied promotion floors. Forced losses, such as
Reductions in Force (RIFs) and Selective Early Retirement Boards
(SERBs), are determined along with promotions.

5.   The number of nonprior service accessions needed to meet
endstrength targets is calculated, and these accessions are added
to the inventories.

6.   Finally, with the flows of personnel into and out of the
inventory determined, the time-to-ETS distribution, which is used
in the calculation of the continuing force, is updated.

These steps are repeated for each projection year. Our
discussion of the projection methodology is organized around
these major steps.

Remove Involuntary Losses

The approach used to model involuntary losses implies an
assumption about what these soldiers would have done if not
involuntarily separated. For example, applying a continuation
rate to an inventory, and then subtracting a user-supplied amount
of involuntary losses to determine actual continuations,

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implicitly assumes that these losses reduce continuations one-for-one. This is unrealistic as some soldiers who are involuntarily separated might have otherwise been normal losses. By removing involuntary losses *before* applying continuation rates, we assume that involuntary losses come both from continuations and normal losses, with the proportion determined by the continuation rate. This is a conservative approach in that we are less likely to overstate the net effect of changes in policies affecting involuntary losses.

In symbols, the adjusted inventory for YOS i, grade j, subinventory k, and projection year t-1, $E^{*}_{i,j,k,t-1}$, is

$$E^{*}_{i,j,k,t-1} = E_{i,j,k,t-1} - RL_{ijkt} - QL_{ijkt} \tag{1}$$

where $E_{i,j,k,t-1}$ is the previous year's inventory, RL_{ijkt} represents the RCP losses in the projection year, and QL_{ijkt} represents QMP losses. The previous year's inventory is baseline data for the first projection year and projected inventories for the remaining years. The equations for estimating RCP and QMP losses are described below.

We use the following conventions for the subscripts to the variables in this section: (1) the index for YOS, *i*, refers to the upper end of the yearly YOS intervals and, therefore, ranges from 1 to 30; (2) the index for grade, *j*, ranges from 3 (E1-3) to 9; (3) the index for subinventory, *k*, ranges from 1 to 25; (4) the index for projection year, *t*, ranges from 1 to 9. Superscripts on the inventory variable, such as the asterisk, indicate intermediate inventories used in the projection process. The year-end inventories -- the output for each projection year -- have no superscript.

RCP Losses. To determine RCP losses, the analyst sets the maximum year of service by grade. Soldiers who have years of service greater than that maximum in the projection year and are at the expiration of their term of service (ETS) are classified as RCP losses. Formally, the number of RCP losses in YOS i, grade j, subinventory k, and projection year t is given by

$$RL_{ijkt} = d^{0}_{i,k,t-1} E_{i,j,k,t-1} \quad \text{for } i > i^{max}_{j}$$
$$RL_{ijkt} = 0 \quad \text{for } i \leq i^{max}_{j} \tag{2}$$

where i^{max}_{j} is the maximum year of service in grade j.

The term $d^{0}_{i,k,t-1}$ is the proportion of soldiers in YOS i and subinventory k who are at ETS in the projection year. This is taken from time-to-ETS (TTE) distributions which describe, for each subinventory, the proportion of soldiers at each YOS with an ETS date in the current projection year, the next year, and so

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on. In our notation, time-to-ETS is indexed by a superscript, ranging from 0 (at ETS) to 5 (five years to ETS). We describe the role of the TTE distributions in more detail in the next section.

QMP Losses. QMP losses are specified by the analyst in two steps. First, the estimated number of losses by grade and projection year is entered. Then, the distribution of these losses across YOS is specified for each grade. Within a YOS/grade cell, losses are distributed across the subinventories in the same proportions as the previous year's inventory. Therefore, QMP losses in YOS i, grade j, and subinventory k is given by

$$QL_{ijkt} = QL_{jt} \rho_{i(j)} \left(\frac{E_{i,j,k,t-1}}{\sum_k E_{i,j,k,t-1}} \right) \tag{3}$$

where QL_{jt} is the number of losses by grade and projection year and the ρ's specify the YOS distribution for each grade. The final term in equation 3 distributes the losses by subinventory.

A given YOS distribution may lead to situations in which the number of losses allocated to a particular YOS/grade/subinventory cell is greater than the population in that cell. EPICC checks for this problem while subtracting QMP losses from the inventory. Infeasible allocations are listed in a report to the user, the maximum possible number of losses is taken, and the projection proceeds.[8]

Continue the Force

In EPICC the continuing force is determined as the sum of three personnel "flows" -- reenlistments at ETS, extensions at ETS, and nonETS continuations. Each flow is estimated by applying cell-specific rates to the number of soldiers in subinventory cells of the adjusted previous year inventories. The rates are based on historical data, adjusted for user-supplied assumptions about changes in compensation and personnel management policies.

There are two reasons for estimating continuations by summing personnel flows rather than applying a single continuation (or loss) rate. First, because of the nature of enlistment contracts, continuation rates at ETS are generally much lower than nonETS continuation rates. Thus, an overall

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[8]Alternatively, if no YOS distribution is specified, the module distributes losses across both years of service and subinventories in the same proportions as the previous year's inventory. This procedure will produce feasible allocations in all inventory cells.

continuation rate is a weighted average of two very different
values, where the weights are defined by the proportion of
soldiers at ETS. Even if the underlying ETS and nonETS
continuation rates are stable, it is unlikely that the proportion
of soldiers at ETS in a given cell would be constant through
time.[9] More accurate overall continuation rates can be obtained
by starting with separate ETS and nonETS continuation rates and
projecting the proportion of soldiers at ETS along with the
inventories. This is the approach used in EPICC.

Second, compensation and personnel management policy changes
have different effects on the various personnel flows. An
increase in the average Selective Reenlistment Bonus (SRB) will
increase reenlistment rates but have little, if any, effect on
nonETS continuation rates. To correctly evaluate the impact of
these policy changes, then, it is necessary to be able to adjust
rates that represent specific types of personnel flows.

In the remainder of this section we describe how each of
these three personnel flows is calculated in the inventory
projection module.

ETS Reenlistments. In EPICC ETS reenlistments are defined
as reenlistments occurring among soldiers who have an ETS date
during the projection year. The equation for ETS reenlistments
in YOS i, grade j, subinventory k, and projection year t, R_{ijkt}^0, is

$$R_{ijkt}^0 = E_{i,j,k,t-1}^* \left(d_{i,k,t-1}^0 \right) \left(r_{ik} \delta_{ikt} \Delta_{ik}^r \right) \tag{4}$$

where the r_{ik}'s are baseline reenlistment rates defined by YOS and
subinventory; δ_{ikt} is a reenlistment rate adjustment factor
determined by compensation and macroeconomic assumptions; and Δ_{ik}^r
is a reenlistment rate adjustment factor used by the analyst to
model changes in personnel management policies.

Equation 4 specifies that reenlistments are the product of
the population "at risk" -- calculated by multiplying the
adjusted previous year inventory times the proportion at ETS --
and a predicted reenlistment rate. The predicted reenlistment
rate is, in turn, the product of three factors -- a baseline ETS
reenlistment rate, an adjustment factor derived from analyst
assumptions about military and civilian compensation, and a user-
specified adjustment factor for changes in personnel management
policies. We describe the methodology for calculating the
baseline reenlistment rates in Appendix B. The compensation
adjustment factors, which vary by projection year, are the output
from the compensation-retention module described in Chapter 3.
The Δ's add flexibility to the inventory projection module.

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[9] For this to be true, the base and projection year
inventories would have to be in a steady-state with constant
endstrength and accessions.

Policy changes that are not explicitly modeled in EPICC can be evaluated using off-line estimates of expected changes in reenlistment (and other) rates. The analyst can define one set of adjustment factors which is applied to all projection years.

Note that the ETS reenlistment rate and the proportion at ETS in each projection year are dimensioned by YOS and subinventory only. Effectively, we assume that the ratio of ETS reenlistments to inventory size is constant across grades *within* a *subinventory/YOS cell*. This assumption greatly reduces the storage requirements of the model, as baseline reenlistment rates and TTE distributions do not have a grade dimension, without significantly affecting the accuracy of the projections. Compared with the variation in reenlistment rates captured by the YOS and subinventory dimensions of the rates, the variation across grade within a subinventory/YOS cell is relatively small.

ETS Extensions. ETS extensions in the inventory module are given by

$$EX^0_{ijkt} = E^{\bullet}_{i,j,k,t-1} \left(d^0_{i,k,t-1} \right) \left(ex_{ik} \Delta^{ex}_{ik} \right) \tag{5}$$

where EX^0_{ijkt} is the number of extensions in YOS i, grade j, subinventory k, and projection year t; ex_{ik} is the baseline extension rate; and Δ^{ex}_{ik} is the personnel management adjustment factor for extensions.[10] Using the same at-risk population, extensions are determined from historical extension rates, as adjusted by the analyst. Like reenlistments, extension rates do not have a grade dimension. Unlike reenlistments, we assume that the number of extensions is not affected by changes in relative military compensation.

User adjustments to ETS reenlistment and extension rates could result in an ETS continuation rate that is greater than 1. EPICC audits the adjusted rates and warns the user if this problem exists.

NonETS Continuations. This flow constitutes the remainder of the continuing force. NonETS continuations are calculated as

$$NC_{ijkt} = E^{\bullet}_{i,j,k,t-1} \left(1 - d^0_{i,k,t-1} \right) \left(nc_{ik} \Delta^{nc}_{ik} \right) \tag{6}$$

where NC_{ijkt} is the number of nonETS continuations in YOS i, grade

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[10]In an inventory model, the definition of a reenlistment and an extension depends on the definition used in constructing the underlying rates. For EPICC we define reenlistments as continuations which increase the ETS date by 36 or more months. An extension increases the ETS date by less than 36 months.

j, subinventory k, and projection year t; nc_{ik} is the baseline nonETS continuation rate; and Δ_{ik}^{nc} is the analyst-supplied adjustment factor for this rate. The number of nonETS continuations is calculated as the product of the inventory at risk for a nonETS decision and adjusted continuation rates. As with reenlistments and extensions, nonETS continuation rates are dimensioned only by YOS and subinventory.

NonETS continuations include a substantial proportion of the total reenlistments and extensions that occur in a given fiscal year. It is important to keep track of nonETS reenlistments and extensions for two reasons. First, the distribution of nonETS continuations among reenlistments, extensions, and year-to-year continuations affects the TTE distribution. A shift toward more early reenlistments will affect the at-ETS proportions in future years, raising the average continuation rate in those years. Second, accurate budget estimates require a realistic estimate of reenlistments because of SRB costs.

We use baseline data to allocate nonETS continuations to reenlistments and extensions. Let rp_i^n be the proportion of continuations that are reenlistments among soldiers with YOS i in time-to-ETS n. Let ep_i^n be the same proportion for extensions. Then nonETS reenlistments, extensions, and year-to-year continuations, which we denote by C, are given by

$$R_{ijkt}^n = NC_{ijkt}\,rp_i^n$$

$$EX_{ijkt}^n = NC_{ijkt}\,ep_i^n \tag{7}$$

$$C_{ijkt}^n = NC_{ijkt}\left(1 - rp_i^n - ep_i^n\right)$$

where these equations are defined for $n>0$. The reenlistment and extension proportions can not be modified by the analyst, however, we anticipate that in future modifications to the model the user will be able to modify these proportions.[11]

With these personnel flows defined, the module calculates total reenlistments, extensions, and normal losses using the following equations:

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[11]Note that equations 6 and 7 imply that non-ETS reenlistments are not adjusted for changes in relative military compensation. We assume that these reenlistments are primarily driven by administrative factors, such as adapting enlistment terms to overseas tour requirements.

$$R_{ijkt} = \sum_n R_{ijkt}^n$$

$$EX_{ijkt} = \sum_n EX_{ijkt}^n \qquad (8)$$

$$NL_{ijkt} = E_{ijkt}^* - \left(R_{ijkt} + EX_{ijkt} + \sum_n C_{ijkt}^n\right)$$

where NL represents normal losses. ETS and nonETS reenlistments are summed to provide total reenlistments during the projection year; total extensions are calculated analogously. Normal losses are simply the difference between the previous year's inventory, adjusted for involuntary losses, and the continuing force.

Add Prior Service Accessions

Prior service accessions are specified by the analyst in two steps. First, the total number of accessions by projection year, A_t^{PS}, is entered. Then, a subinventory distribution, η_k, and a grade distribution, μ_j, are specified; both distributions are used for all projection years. Prior service accessions are distributed across the remaining inventory dimension, YOS, in proportion to the adjusted previous year inventory. The equation for prior service accessions by inventory cell is

$$A_{ijkt}^{PS} = A_t^{PS} \eta_k \mu_j \left(\frac{E_{i,j,k,t-1}^*}{\sum_i E_{i,j,k,t-1}^*} \right) \qquad (9)$$

With the third step complete, the continuing force plus prior service accessions can be calculated as

$$E_{ijkt}^C = R_{i-1,j,k,t}^0 + EX_{i-1,j,k,t}^0 + NC_{i-1,j,k,t} + A_{ijkt}^{PS} \qquad (10)$$

where the superscript C on the inventory variable denotes the continuing force, as adjusted for both involuntary losses and prior service accessions. Note that at this point, we "age" the force by increasing the year of service index. This implies that all continuation flows are indexed by a soldier's YOS at the end of the previous year. We use this convention, rather than reporting continuation flows by YOS at the end of the projection year, so that the flows can be easily matched to inventories from which they are generated.

Calculate Promotions

The third step of the projection methodology calculates promotions. The model promotes to fill vacancies, subject to user-supplied promotion floors. If these floors exceed the available vacancies, forced losses in the form of RIFs and SERBs are generated to provide sufficient additional vacancies to meet

the specified promotion minimums.

This approach implies that promotions[12] for a particular grade are the maximum of (1) vacancies in that grade and (2) the minimum number of promotions for that grade. Starting with E9, the number of promotions in projection year t, $P_{9,t}$, is given by

$$P_{9,t} = \max\left(V_{9,t}, P_{9,t}^{\min}\right)$$

where

$$V_{9,t} = S_{9,t} - \sum_i \sum_k E_{i,9,k,t}^C$$
$$P_{9,t}^{\min} = \left(\sum_i \sum_k E_{i,9,k,t}^C\right) p_9 \Delta_{9,t}^P$$

(11)

$V_{9,t}$ is the number of E9 vacancies in projection year t. It equals the E9 requirement in year t, $S_{9,t}$, minus the continuing force of E9's, which is calculated by summing over YOS and subinventory. Requirements are specified by the analyst as part of the projection scenario. $P_{9,t}^{\min}$ is the minimum number of promotions, which is calculated as the product of the E9 continuing force; baseline promotion rates, p_9, and user-supplied adjustment factors, $\Delta_{9,t}^P$, which can be defined by projection year.[13]

If the minimum number of E9 promotions exceeds E9 vacancies, forced losses equal to the excess are removed from the continuing inventory. Thus, forced losses are defined as

$$FL_{i,9,k,t} = \max\left(P_{9,t}^{\min} - V_{9,t}, 0\right) \left(\frac{E_{i,9,k,t}^C}{\sum_i \sum_k E_{i,9,k,t}^C}\right)$$

(12)

where $FL_{9,t}$ is the number of E9 forced losses in projection year t. In the current version of the model, these losses are allocated across YOS and subinventory cells in proportion to the continuing force. A rule-based allocation procedure is under development as a modification to the model.

The distribution of total E9 promotions by year of service is determined by the analyst, who selects "primary" and "secondary" promotion zones and a ratio of secondary to primary

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[12]Promotions in EPICC are defined as the actual advancement to the next grade, i.e., the "pin-on" points.

[13]Note that we are using the DCSPER definition of "promotion rate", which is the number of promotions into grade E9 divided by the E9 *endstrength*. Although this is different from the traditional method of calculating promotion rates, it was the definition being used by DCSPER at the time of model development.

promotions. The distribution then is defined as

$$P_{i,9,k,t} = \theta P_{9,t} \left(\frac{E^C_{i,9,k,t}}{\sum_i E^C_{i,9,k,t}} \right) \qquad \text{for } i \text{ in the secondary zone}$$

$$P_{i,9,k,t} = (1-\theta) P_{9,t} \left(\frac{E^C_{i,9,k,t}}{\sum_i E^C_{i,9,k,t}} \right) \qquad \text{for } i \text{ in the primary zone} \tag{13}$$

$$P_{i,9,k,t} = 0 \qquad \text{otherwise}$$

where θ is the proportion of promotions occurring in the secondary zone. This same sequence of steps is then repeated to determine E8 promotions, and so on.

Finally, the year-end inventory for projection year t is calculated by combining the continuing force, forced losses, and promotions in and out as

$$E_{ijkt} = E^C_{ijkt} - FL_{ijkt} + (P_{ijkt} - P_{i,j+1,k,t}) \tag{14}$$

This equation is defined for YOS 1-2 through YOS 29-30+; the final inventory in YOS 0-1 is determined in the next step.

Calculate Nonprior Service Accessions

Having estimated all the losses from the inventory, we calculate the number of nonprior service (NPS) accessions required to meet a user-supplied endstrength goal for the projection year. Analytically, it is convenient to divide the computations into two parts.

First, we determine the number of soldiers needed in the YOS 0-1 cells to meet the endstrength goal. This is given by

$$\sum_k E_{1,3,k,t} = \sum_j S_{jt} - \sum_k \left(\sum_{j=2}^{30} \sum_j E_{ijkt} \right) \tag{15}$$

The left-hand side of equation 15 is the inventory in YOS 0-1 and grade E1-3, summed across the subinventories. This must equal the endstrength constraint in projection year t, displayed as the sum of the requirements by grade, less the continuing force.

Because of attrition between the accession point and the end of a fiscal year, the number of accessions required to meet the endstrength goal will be greater than the required YOS 0-1 inventory. The equation for the total number of nonprior service accession required in projection year t is

$$A_t^{NPS} = \frac{\sum_k E_{1,3,k,t}}{\sum_k \lambda_k \left[\sum_{m=1}^{4} \phi_m \prod_{n=1}^{5-m} (1 - a_{nk}) \right]} \qquad (16)$$

The numerator is the required YOS 0-1 endstrength, taken from the previous equation.

The denominator is the rate at which the accession flow is "converted" to the YOS 0-1 stock. Because the required number of accessions is sensitive to the value of this conversion rate, we pay special attention to the factors that affect it. The overall conversion rate is calculated as a weighted average of the rates by subinventory -- the expression in brackets -- with the weights being user-defined proportions of accessions for each subinventory, the λ's. Thus, when the analyst modifies the accession mix by quality or demographic characteristics, the number of accessions needed to achieve a particular endstrength will change.

The subinventory conversion rates are, in turn, a weighted average of subinventory-specific 3-month attrition rates, the a's, where the weights are the proportion of total accessions entering in each quarter of the fiscal year, ϕ_m.[14] Therefore, the conversion rate is also sensitive to the timing of accessions.

The distribution of accessions across subinventories, the attrition rates by subinventory, and the quarterly distribution factors can all be modified by the user of EPICC. Nonprior service accessions by subinventory, A_k^{NPS}, are simply the product of total accessions and the subinventory distribution factors.

Update Time-to-ETS Distribution

This is the final step in the projection algorithm for each year. The TTE distribution is projected using the continuation flows determined in steps 2 and 3 and user-supplied distributions for initial term, reenlistment, and extension lengths. With access to the initial term distribution, for example, the analyst can project the future inventory effects of changing the mix of accession terms.

Let γ_2 through γ_6 be the proportions of nonprior service accessions enlisting for terms of 2 through 6 years. Then, the new TTE distribution for soldiers in the YOS 0-1 cell is simply given by

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[14]These attrition rates are defined as the proportion of soldiers starting a 3-month service interval who have left by the end of the interval.

$$d^0_{1,k,t} = 0$$

$$d^n_{1,k,t} = \gamma_{n+1} \qquad \text{for } n > 0 \tag{17}$$

That is, the proportion of soldiers who will be one year away from ETS in the next projection year is the proportion of two-year nonprior service accessions, and so on.

Let τ_1 and τ_2 be the proportions of extensions for 1 and 2 years. Then, the values of d^0 and d^1 for soldiers in YOS categories 1-2 through 29-30+ are given by

$$d^0_{ikt} = \left(C^1_{ikt} + \tau_1 EX^0_{ikt}\right) / E^C_{ikt}$$

$$d^1_{ikt} = \left(C^2_{ikt} + \tau_2 EX^0_{ikt} + \tau_1 EX^1_{ikt}\right) / E^C_{ikt} \tag{18}$$

That is, next year's at-ETS population includes soldiers one year away from ETS in the current projection year who continue, C^1, and soldiers at ETS in the current projection year who extend for one year, EX^0. The *proportion* at ETS is the number in these categories divided by the continuing force inventory.[15] Both 2-year extensions for those at ETS in the current projection year and 1-year extensions for those one year away from ETS currently will result in being one year away from ETS in the next projection year.

Reenlistments and prior service accessions enter the calculations for those two years away from ETS in the next projection year. Let π_3 through π_6 be the proportions of reenlistments for 3 through 6 years. Dropping the subscripts, the formula for d^2 for soldiers in YOS categories 1-2 through 29-30+ is

$$d^2 = \left[C^3 + \tau_2 EX^1 + \tau_1 EX^2 + \pi_3(R^0 + A^{PS})\right] / E^C \tag{19}$$

Note that we assume that prior service accessions have a time-to-ETS distribution similar to reenlistments, not initial enlistments.

The equations for the remaining TTE categories are

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[15]Forced losses are not explicitly used in calculating the new TTE distribution. This is equivalent to assuming that these losses are drawn proportionately from the TTE distribution.

$$d^3 = \left[C^4 + \tau_2 EX^2 + \tau_1 EX^3 + \pi_4(R^0 + A^{PS}) + \pi_3 R^1 \right] / E^C$$

$$d^4 = \left[C^5 + \tau_2 EX^3 + \tau_1 EX^4 + \pi_5(R^0 + A^{PS}) + \pi_4 R^1 + \pi_3 R^2 \right] / E^C$$

(20)

$$d^5 = \left[\tau_2 EX^4 + (\tau_1 + \tau_2) EX^5 + \pi_6(R^0 + A^{PS}) + \left(\sum_{m=5}^{6} \pi_m \right) R^1 + \left(\sum_{m=4}^{6} \pi_m \right) R^2 \right.$$
$$\left. + R^3 + R^4 + R^5 \right] / E^C$$

Note that we constrain the maximum TTE to be 5 years. Because there are very few soldiers who, more than 2 years away from their ETS, extend their ETS date by more than 3 years, this simplification will not introduce significant errors into the TTE projections.

Inventory Module Inputs and Outputs

Inputs to the inventory module fall into two categories: scenario assumptions and baseline data.

Table 1

Inventory Projection Scenario

Scenario Assumption	Specified By
Compensation/macroeconomic scenario (Sec 3)	Projection year
Strength Constraints • Baseline inventory[16] • Initial time-to-ETS distribution[16] • Requirements/Endstrength • Accession distribution • Quarterly timing of NPS accessions/losses	Grade, subinventory, YOS YOS Projection year, grade Projection year, subinv Projection year
Promotion Parameters • Minimum promotion rates • Promotion rate adjustment factors • Primary/secondary zones • Ratio of secondary to primary zone promotions	Projection year, grade Projection year, grade Grade Grade
PS Accessions • Number • Grade distribution • Subinventory distribution	Projection year
Retention Rates/Adjustment Factors • Reenlistment rates • Extension rates • Non-ETS continuation rates	Year, YOS, subinventory Year, YOS, subinventory Year, YOS, subinventory
Involuntary Losses • Retention control points (RCPs) • QMP losses • Distribution of QMP losses	Projection year, grade Projection year, grade Grade, YOS
Distribution of Term Lengths • Initial term lengths • Reenlistment term lengths • Extension term lengths	Projection year, subinv Projection year Projection year

     Table 1, above, summarizes the scenario assumptions we have discussed in this section. When the inventory module is activated, these assumptions are set at default values calculated from baseline data. However, all of these assumptions can be modified by the analyst using a series of menu-driven screens, and the modifications stored as a new scenario. The baseline data requirements for the inventory projection module are described in Appendix B.

     Output from the inventory module is available at two levels of detail. The summary level output provides the user with key

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[16]User does not have access to starting inventories.

categories of output dimensioned by projection year or projection year and grade. The next level of detail provides the user with a complete set of output for all categories of data by subinventory, grade, and YOS. The breakout of data that is available is summarized in Table 2.

In addition to the output files described in Table 2, the model will generate files that can be imported to a standard spreadsheet program. The "Report Generator" function will parse the output data with delimiters and, for the mid- and detailed level, will break the single output files into separate files for each category.

Table 2

Inventory Module Output

Category	Level of Detail	
	Summary	Summary by Subinv
End Strength	grade x PY	YOS and grade totals
Total Losses		YOS and grade totals
Normal Losses	grade x PY	YOS and grade totals
RCP Losses	PY	YOS and grade totals
Forced Losses	grade x PY	YOS and grade totals
QMP Losses	grade x PY	YOS and grade totals
NPS Attrition Losses	grade x PY	Total
Total Accessions	PY	
NPS Accessions	PY	Total
PS Accessions	PY	YOS and grade totals
Total Reenlistments	grade x PY	YOS totals
Total Initial Reenlistments	PY	
Total Mid-term Reenlistments	PY	
Total Career Reenlistments	PY	
ETS Reenlistments	grade x PY	YOS totals
ETS Initial Reenlistments	PY	
ETS Mid-term Reenlistments	PY	
ETS Career Reenlistments	PY	
Non-ETS Reenlistments	grade x PY	YOS totals
Non-ETS Initial Reenlistments	PY	
Non-ETS Mid-term Reenlistments	PY	
Non-ETS Career Reenlistments	PY	
Extensions		YOS totals
Promotions	grade xPY	
Percent of Historical Promotion Rate[17]	grade x PY	
Percent Minority[17]	grade x PY	
Percent Cat I-IIIA[17]	grade x PY	

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[17]Percentages can be easily tailored to user's needs

COMPENSATION-REENLISTMENT MODULE

The compensation-reenlistment module uses the analyst's assumptions about military compensation and macroeconomic conditions over the projection period to adjust base year reenlistment rates for changes in these factors. The adjusted rates are then used in the inventory projection to age the force.

By establishing a link between military compensation and reenlistment rates, this module allows the analyst to address the following types of issues:

1. What are the inventory and manpower cost implications of proposed pay raise and allowance changes? If military pay is projected to decline relative to the civilian sector, for example, how much will voluntary losses increase? What are the added costs of maintaining a given endstrength in this environment, including increased accessions and training?

2. What are the likely effects of changes in unemployment and civilian wage inflation on the inventory? How will losses change and what costs must be incurred to achieve endstrength targets? How will the composition of the inventory change across demographic and quality dimensions?

3. What are the likely effects of a proposed temporary separation incentive? What additional losses will be realized and how will this effect the composition of the enlisted force?

4. What is the appropriate mix of compensation elements in the military pay and benefits package? How would increasing basic pay but reducing retirement benefits, for example, affect the career content of the enlisted force?

Issues like these arise annually in the budget planning process and sporadically as particular portions of the military compensation package are reassessed in study groups like the Quadrennial Review of Military Compensation (QRMC). Without the compensation-reenlistment module, they can only be evaluated using *ad hoc* adjustments to the baseline reenlistment rates.

Figure 3 provides an overview of the compensation-reenlistment module. User-defined assumptions about compensation policies and macroeconomic factors are the primary inputs to the module. The outputs are reenlistment rate adjustment factors by projection year, YOS, and sub-inventory.

As in any modeling effort, the accuracy of the projections under different compensation scenarios is only as good as the quality of the compensation-reenlistment link. Our methodology, derived from the Annualized Cost of Leaving (ACOL) model of reenlistment behavior, has a sound theoretical foundation and a successful track record in similar policy applications. The specific implementation of the methodology is guided by the findings from the Army Compensation Models Project (ACOMP). In
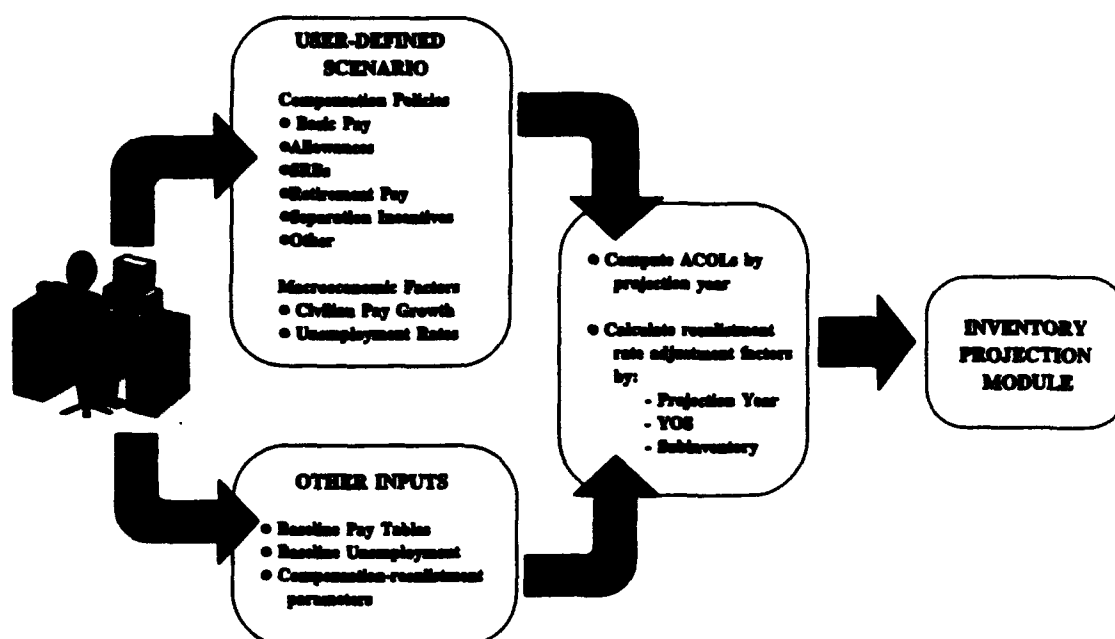
Figure 3. Compensation-Retention Module Schematic

this project compensation-reenlistment models were estimated and tested for selected CMFs.

This chapter describes the compensation-reenlistment link. The first part of this chapter describes the adjustment equations used to modify the reenlistment rates. The next section describes the variables used in the adjustment equations and outlines how they are obtained. In the final part of this chapter we detail how to estimate the key parameters of the adjustment equations.

Adjustment Equations Modify the Reenlistment Rates

Let r_{ik} be the base-year reenlistment rate in year of service (YOS) i and subinventory k. The adjusted reenlistment rate for projection year t is given by

$$r_{ik}^t = \frac{1}{1 + e^{-z_{ik}^t}}$$

where $\quad z_{ik}^t = z_{ik}^0 + \alpha_i^{ACOL}\left(ACOL_i^t - ACOL_i^0\right) + \alpha_i^{UN}\left(UN^t - UN^0\right)$ (21)

$$z_{ik}^0 = \ln\left(\frac{r_{ik}}{1 - r_{ik}}\right)$$

The superscript t indicates projection year (0 is the base year), the ACOL's are annualized cost of leaving variables calculated from user assumptions about military/civilian compensation and projected promotion patterns, the UN's are user-supplied projections of unemployment, and the α's are parameters.

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To reduce computation time, we calculate ACOLs only by year of service and fiscal year. That is, the same ACOL changes are used to adjust reenlistment rates for all subinventories. Even with the same ACOL changes, the difference between adjusted and base year reenlistment rates will vary across subinventories for two reasons. First, different α's are used for high quality and other subinventories. Second, the adjustment produced by equation (21) depends on the level of the base year rate, which varies across subinventories.

Variables in the Adjustment Equations

For the base year and each projection year, the adjustment equation requires a vector of ACOLs by YOS and an unemployment rate. The base-year values can be calculated once and stored; the projection-year values depend on user-supplied assumptions and the results of the inventory projection.

Consider the ACOLs first. They are defined as

$$ACOL_i^t = \max_s \left[\frac{\sum_{n=i}^{i+s} \left(WM_n^t - WC_n^t + O_n\right)d^{n-i} + \left(d^s R_{i+s}^t - R_i^t\right) - SI_i}{\sum_{n=i}^{i+s} d^{n-i}} \right] \quad (22)$$

where

- s is career length. Career length runs from 1 to 30-i, in increments of one year. For each year of service, ACOLs must be calculated for all potential career lengths and the maximum ACOL value chosen.

- WM_n is expected annual military compensation. It is calculated for each year of service as

$$WM_n^t = \frac{1}{p^t} \sum_{j=1}^{9} \left[BP_{nj}^t\left(1 + 0.25 SRB_n^t ETS_n^t\right) + AL_j^t\right]\rho_{nj}^t \quad (23)$$

where BP_{nj} is basic pay in year t for grade j and YOS n, SRB_n is the average SRB multiplier for YOS n, ETS_n is the proportion of soldiers at ETS in YOS n, AL_j is the sum of allowances for grade j in year t, p^t is an inflation index for projection year t (base year index equals 1), and ρ_{nj} the proportion of soldiers with YOS n who are in grade j.

Basic pay and allowances are derived from the base-year pay and allowance tables, adjusted by the appropriate pay and allowance increases assumed by the user. SRB payments are estimated using the average multiplier (including zero for MOSs without a bonus), the proportion of soldiers at ETS, and an assumed three-year

reenlistment term. The p's are generated from user-supplied assumptions about inflation rates in the projection years. The ρ's are calculated from the total enlisted inventory projected for the end of the previous year.

Basing expected military compensation on projected grade distributions goes part of the way to closing the promotion-pay loop discussed in the design paper. If promotions slow down, for example, the cost of leaving, and reenlistment rates, will fall because expected military pay is lower. This interaction between the inventory and compensation-reenlistment models is an improvement over the initial approach, but it does mean that the compensation-reenlistment module must be exercised at the beginning of each projection year.

- WC_n is expected annual civilian compensation. It is calculated from an earnings function with the form

$$WC_n^t = \exp(\beta_0 + \beta_1 i + \beta_2 i^2)\left(\frac{w^t}{p^t}\right) \qquad (24)$$

where w^t is an index of civilian wage inflation in projection year t relative to the base year.[18] The β parameters will be supplied from ACOMP research results.

- O_n is other compensation. This vector of inputs allows the user to model the reenlistment rate effects of new military pays (positive values) or monetary incentives to leave (negative values).

- d is a real discount factor. This should be a variable in the code, although it does not need to be accessible to the user. Initially assume a 10% discount rate, which means that d should equal $1/(1.1)$.

- R_{i+s} is the annual value of retirement pay for a soldier retiring with $i+s$ years of service. There are three formulas for retirement pay depending on

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[18]Equations (23) and (24) use wage and price inflation factors to express both WM and WC in base-year dollars.

the soldier's accession year

$$\text{I.} \quad R_{i+s}^{t} = \left[.025(i+s) \left(\frac{BP_{i+s}^{t}}{p^{t}} \right) \right] \sum_{n=i+s+1}^{57} d^{n-i}$$

$$\text{II.} \quad R_{i+s}^{t} = \left[.025(i+s) \left(\frac{BP_{\overline{i+s}}^{t}}{p^{t}} \right) \right] \sum_{n=i+s+1}^{57} d^{n-i}$$

$$\text{where} \quad BP_{\overline{i+s}}^{t} = \frac{BP_{i+s}^{t} + .952\, BP_{i+s-1}^{t} + .907\, BP_{i+s-2}^{t}}{3}$$

$$\text{III.} \quad R_{i+s}^{t} = \left[.025(i+s) \left(\frac{BP_{\overline{i+s}}^{t}}{p^{t}} \right) \right] \sum_{n=i+s+1}^{57} d^{n-i} - \left[.01(30-i-s) \left(\frac{BP_{\overline{i+s}}^{t}}{p^{t}} \right) \right] \sum_{n=i+s+1}^{44} d^{n-i}$$

$$(25)$$

Under all three formulas, retirement pay is positive only if years of service at retirement, $i+s$, is greater than or equal to 20. This means that the two values of R in equation (22) only need to be calculated for decisions at YOS 20 and greater.[19]

Formula I applies to soldiers who entered before FY81. They receive 2.5% of their highest-year basic pay -- we assume that is the last year -- from the year following separation until death, which we assume occurs at age 75.[20] Formula II, which bases retirement pay on the high-three average of basic pay, applies to soldiers enlisting between FY81 and FY86.[21] Formula III, which cuts retirement pay rates from retirement through age 62 (or YOS 44), is for soldiers entering after FY86. In all cases, basic pay is deflated by the price index to measure retirement in the same year dollars as the other

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[19]The discounting factors in equation (25) can be more easily calculated by combining present value and annuity formulas, as follows:

$$\sum_{n=i+s+1}^{N} d^{n-i} = d^{s+1} \left[\frac{1 - d^{(N-i-s-1)}}{d^{-1} - 1} \right]$$

where N is either 44 or 57.

[20]Assuming accession at age 18, the imputed YOS at age 75 is 57.

[21]It is nominal, rather than real, pay which counts in this calculation. The real values of BP for the preceding two years must, therefore, be deflated. We assume a 5% pay raise in equation (25).

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compensation elements.

Note that because these formulas are tied to accession cohorts, the appropriate formula to use in calculating retirement pay for decisions at a given year of service depends on the projection year. As the projection proceeds, more years of service will fall under the newer, and less generous, retirement systems, causing reenlistment rates to fall *ceteris paribus*. This is an important application of the compensation-reenlistment link.

- SI_i is the annual value of a separation incentive offered in YOS i. It is multiplied by a factor that represents the proportion of soldiers eligible for the incentive in YOS i and MOS k. SI_i is calculated with the equation

$$SI_i = \left[mult(i) \left(\frac{\sum_{0}^{m} \left(\frac{1}{(1+r)} \right)^{t} BP_i^{t}}{m} \right) \right]_{n=i+1}^{x(i)} \sum d^{n-1} \qquad (26)$$

where mult(i) is the product of a user supplied multiplier times the number of years served at the time of separation, i. The next term calculates the value of the soldiers average base pay over the last m years of service. The last term discounts the value of annuities that will be paid to the separated soldier over x(i) years to a present value, where x is a user supplied multiplier.

Note that these calculations only apply to a single separation program for a single year. In addition, this algorithm takes into account the "lagged effect" caused by soldiers being forced to make a reenlistment decision early. With the increased losses from nonETS cells, there will be a smaller than normal inventory aging into the ETS cells and thereby will effectively reduce reenlistments in subsequent projection years.

The other variable in the adjustment equation, the unemployment rate series, consists simply of a base-year value -- the national unemployment rate for 18-64 year olds -- and assumptions about projection year values that are supplied by the user.

Parameters of the Adjustment Equation

The α's in equation (21) are derived in the model from user-

supplied pay and unemployment elasticities.[22] This gives the model an advantage in that the ACOL calculations no longer have to mirror the ACOL calculations used in the econometric estimation. The elasticities serve as a common metric for translating ACOL coefficients based on one definition of the annualized cost of leaving into ACOL coefficients consistent with equation (22).

This solves two problems usually encountered in implementing an ACOL-based compensation-retention link. First, making the ACOL calculations in the projection model and the econometrics match usually means ignoring some of the individual detail that can be used in the econometric modeling.[23] When the ACOL calculations don't have to be identical, the best econometric results can be pursued. Second, the model is more flexible because new research results on the reenlistment effects of relative pay and unemployment changes can be incorporated into EPICC without reprogramming the model.

Our method is to solve for the α^{ACOL} parameters that, using equation (21), produce the percentage change in reenlistment rates expected, given the assumed pay elasticities, with a 10% increase in basic pay and allowances. This yields

$$\alpha_i^{ACOL} = \frac{1}{ACOL_i^*}\left[-\ln\left(\frac{1+e^{-z_i^0}}{r_i^*+1}-1\right)-z_i^0\right]$$

(27)

$$\text{where} \quad ACOL_i^* = \left(ACOL_i^{+10}-ACOL_i^0\right)$$

$$r_i^* = 0.1\eta_i^{PAY}$$

$ACOL^{+10}$ is the ACOL value that results when basic pay and allowances are increased by 10%, and η^{PAY} is the reenlistment pay

$$\alpha_i^{UN} = \frac{1}{UN_i^*}\left[-\ln\left(\frac{1+e^{-z_i^0}}{r_i^*+1}-1\right)-z_i^0\right]$$

(28)

$$\text{where} \quad UN_i^* = \left(UN_i^{+10}-UN_i^0\right)$$

$$r_i^* = 0.1\eta_i^{UN}$$

_____

[22]For a more detailed discussion of how to apply these elasticities, see Appendix D.

[23]Two examples where econometric estimation can be more precise than is feasible in aggregate models are predicting promotion points using individual-based promotion time models and adjusting for time censoring through methods such as the ACOL-2 model.

elasticity. The formula for the α^{UN} parameters is analogous.

In each of these equations the α's need only be recalculated if (1) the elasticity assumptions are changed or (2) the base year is updated. We have made initial estimates for both the pay and unemployment elasticities using ACOMP and other research results and provided them as default values in the model.

Separation Incentives in EPICC

In those situations when a separation incentive is in effect, the adjusted retention rate is actually a blended rate resulting from a weighted average of the "old" and "new" rate. The "old" rate is the adjusted rate *without* the affect of the separation incentive. The "new" rate is the adjusted retention rate *with* the affect of the separation incentive. The blended rates are calculated in the following way.

$$r_{new} = (1-e)\, r_{old} + (e)\, r_{si}$$

$$cr_{new} = (1-e)\, cr_{old} + (e)\, r_{si}$$

(29)

where r_{old} is the reenlistment rate with no incentive, r_{si} is the reenlistment rate given a separation incentive, cr_{old} is the continuation rate with no incentive for soldiers not at ETS, and e is the percentage of soldiers eligible for the separation incentive.

Note we estimate continuation rates in the presence of a separation incentive by blending existing continuation rates with adjusted reenlistment rates. A separation incentive affects the retention of nonETS soldiers in two ways. They receive additional compensation for leaving, and they have the opportunity to make a "reenlistment" decision prior to their ETS (the same effect as an early out program).

Lifting the term commitment through a separation incentive will also cause lagged effects on the reenlistments observed for the affected cohorts in years after the program. NonETS soldiers who are offered an incentive, but choose to stay, will likely reenlist at higher rates when their ETS arrives. To model these effects, we assume those who were eligible for the separation incentive and stayed, will reenlist at the higher continuation rate rather than the normal reenlistment rate.

Given this assumption, the reenlistment rate for ETS soldiers in the year following their eligibility for a separation incentive is calculated as

$$r_{new} = (e^*)\, cr_{old} + (1-e^*)\, R_{old}$$

(30)

$$\text{where} \quad e^* = \frac{(e)\, r_{si}}{[(e)\, r_{si} + (1-e)\, cr_{old}]}$$

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The term e^* is the proportion of the remaining members of the affected cohort that were eligible for the incentive. It will be less than e because of the higher separation rate among the eligibles. Because $cr_{old} > r_{old}$, equation 30 increases the reenlistment rate, as desired. We recalculate the reenlistment rates of cohorts affected by a separation incentive program for 3 years after the program year.

Table 3 summarizes the various effects of a separation incentive on soldier retention and shows which are incorporated by the approach used in EPICC.

Table 3

Separation Incentive Effects in EPICC

Effects of Separation Incentive	Modeled in EPICC

Program year effects on retention rates
    - Additional civilian pay
    - Term of service commitment lifted
    - Change in pay elasticity
	
	yes
	yes
	yes

Lagged effect on reenlistments
    - Lifting term commitment
    - Change in taste distribution
	
	yes
	no (small effect)

Reenlistment rate changes in anticipation of incentives	no (DRM and expectations model required)

Summary

Our design for this module has the following features:

1. A wide variety of military pay policies can be easily modeled.

2. The methodology for linking compensation to reenlistment is based on the ACOL model, the most widely used approach in assessing the retention effects of alternative compensation policies.

3. The research design for estimating the critical compensation-retention parameters is based on findings from the Army Compensation Models Project.

This completes the discussion of the compensation-reenlistment module. The next chapter discusses the estimation of costs.

COST ESTIMATION MODULE

This module calculates the budget costs of the enlisted inventories projected in the inventory module. Because the cost estimation process is fully integrated with the inventory projections, little additional user effort is required to obtain cost information along with personnel counts. This adds an important dimension to a personnel policy analysis model, as different strategies for achieving a desired force structure can be easily evaluated on the basis of their expected costs.

The cost estimation methodology in the EPICC model is derived from the budget model in the Army Manpower Cost System (AMCOS). The chapter is divided into three parts. The first part provides an overview of the cost estimation methodology used in EPICC. Next, the chapter describes how each of the various elements that are included in personnel costs, such as military pay, recruiting costs, and PCS expenditures, are estimated. Finally we summarize the cost information that is generated by this module. Appendix B. provides a detailed discussion of the cost methodologies, variable definitions, and data requirements.

EPICC Cost Estimation Methodology

The EPICC cost module estimates costs in a two-step process as shown in Figure 4. First, cost factors representing all the major personnel cost elements are calculated using baseline cost data, cost equations, and user assumptions. These factors measure the budget or flow costs associated with a particular event, such as an accession or reenlistment, or associated with maintaining a stock of soldiers over a period of time, such as annual basic pay. The cost factors are stored in a structured cost data base (SCDB).

In the second step of the EPICC cost module methodology, the cost factors are applied against a personnel inventory. The results are summed to provide a total cost estimate, as well as costs disaggregated by major appropriation, grade, and cost element.

One of the strengths of this approach is that the assumptions underlying the calculation of many of the cost factors can be changed to tailor cost estimates to the needs of a particular analysis. For example, Permanent Change of Station (PCS) costs depend, among other factors, on the number of rotational moves and the number of such moves depends on policy variables such as the proportion of soldiers stationed OCONUS and the average OCONUS tour length. Cost estimates based on simple averages of historical PCS costs cannot reflect the cost effects of changes in these variables. The cost factors are specified, through the cost equations, as functions of important policy variables. When the user changes these policy variables, the cost factors are modified appropriately.
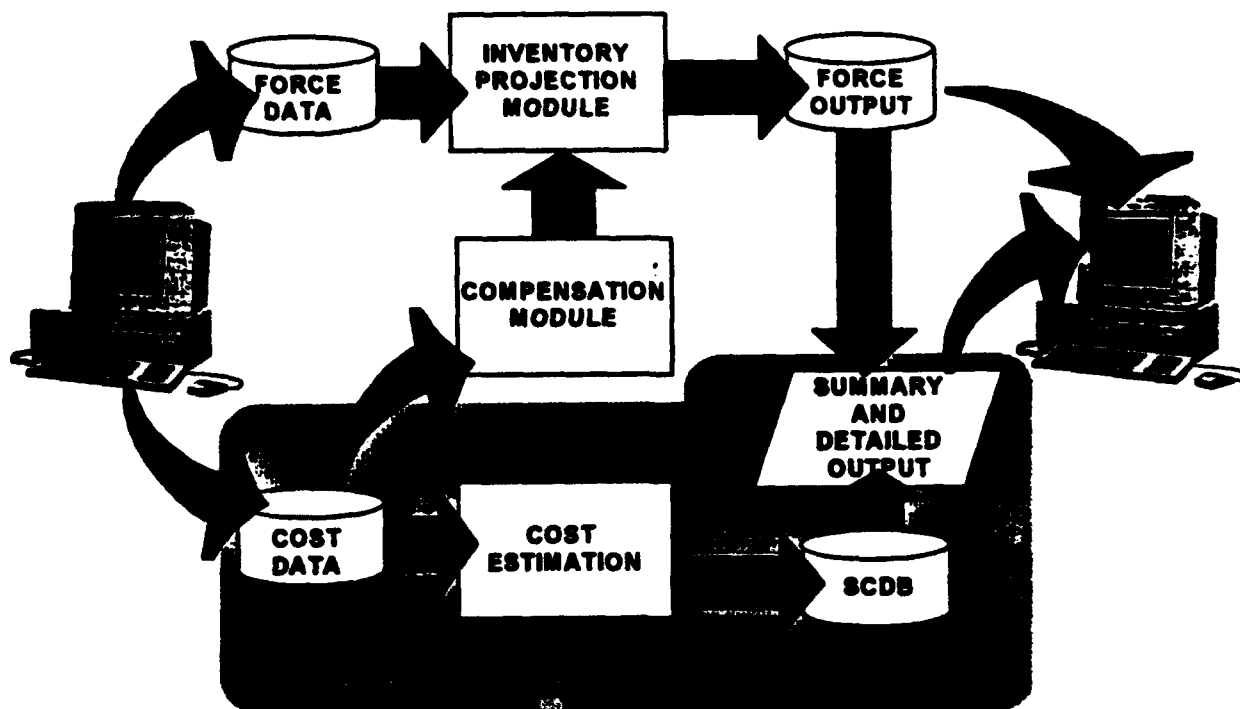
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Figure 4. Diagram of the Cost Module Interface

In keeping with our goal of providing a flexible analysis tool the design of the cost estimation module for the EPICC model allows almost all of the underlying assumptions used in the cost estimation equations to be modified by the user. Analysts can always use the default assumptions to provide an easily-defined common basis for force costing.

In the next section we describe the details of the cost estimation process.

Estimating Budget Costs

This section is organized by the major cost elements. First we describe the costing methodology for the six elements which the user can modify. In each of these the user may adjust the assumptions underlying the estimation of the cost factors. These cost elements are basic pay and allowances, recruiting costs, reenlistment costs, permanent change of station costs, training costs, and separation costs. In the discussion for each of these cost elements, we review the cost equations, noting the data sources and the assumptions that can be changed by the analyst. We also describe how the cost factors resulting from those equations are applied against output from the inventory projection module. The remaining cost factors, which cannot be changed by the user, are discussed next. Finally, we describe some additional cost estimation options available to the EPICC user.

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Basic Pay and Allowances

This cost element includes basic pay, quarters (BAQ) and subsistence (BAS) allowances, and variable housing allowances (VHA).

1. The cost factors for basic pay are defined by grade and year of service. They are calculated simply by updating the baseline annual pay table according to the growth rates in military pay assumed by the analyst.

2. The cost factors for BAQ, BAS, and VHA are defined by grade. First, the baseline annual allowance tables are increased to reflect the growth in allowances assumed by the user. Then, the table amounts are weighted by the proportion of soldiers with and without dependents (BAQ) and the proportion of soldiers receiving housing allowances (BAQ, VHA).[24]

E   ise these cost factors are defined on an annual basis, they wiii be applied against the *man years* in a grade or grade-YOS cell for a projection year. Man years will be estimated in the cost module using the beginning and ending inventories for a projection year and the assumptions made by the analyst about the quarterly timing of accessions, losses, and promotions.

Let E_{ijt}^n be the inventory in year of service i, grade j, and projection year t at the end of the nth quarter. It is given by

$$E_{ijt}^n = E_{i,j,t-1}^4 - [(\sum_{m=1}^{n} .25) C_{ijt}] - [(\sum_{m=1}^{n} q_L^m) L_{ijt}]$$
$$+ (\sum_{m=1}^{n} .25) [C_{i-1,j,t} + (\sum_{m=1}^{n} q_P^m) (P_{i,j-1,t} - P_{ijt})] \qquad (31)$$
$$+ (\sum_{m=1}^{n} q_A^m) A_{ijt}$$

C_{ijt} are the continuations (reenlistments + extensions + nonETS continuations) in an inventory cell defined by year of service i, grade j, and projection year t. L_{ijt} are the losses (separations + lateral losses) from the same cell. P_{ijt} are the promotions out of the cell. A_{ijt} are the accessions (nonprior service + lateral accessions) into the cell. Finally, q_L^m, q_P^m, and q_A^m are the user-specified proportions of losses, promotions, and accessions occurring in the mth quarter.

Starting with last year's inventory in a particular cell, we

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[24] The default values for the dependents status and allowance recipients proportions are defined by grade using baseline data. The user, however, can change these values.

age one-fourth of the continuing force out of the cell (first brackets) each quarter; take q_L of the losses each quarter (second brackets), age in one-fourth of the continuations from the preceding year of service, adjusted for q_P promotions into and out of the cell (third brackets); and add q_A accessions.

To obtain average man years, the quarterly inventories are averaged as follows

$$MY_{ijt} = \frac{E^4_{i,j,t-1} + \sum_{n=1}^{4} E^n_{ijt}}{5} \qquad (32)$$

where MY is man years. Although these calculations seem somewhat complex, we believe the importance of pay and allowances in personnel costs makes the effort to get a better estimate of man years worthwhile.

Accession Costs

The recruiting cost function developed under the original EPICC contract, and described in Appendix C, replaces the AMCOS methodology for calculating accession costs in EPICC. Implementation is discussed in two parts: the inputs to the cost function and the cost/resource outputs.

Input. The analyst enters inputs organized into six categories as follows:

1. Enlistment supply elasticities. The input screen displays a default set of elasticities which, with the exception of the constant, can be changed by the user. If any of the elasticities are changed, EPICC will recalculate the constant to assure that the enlistment supply function is still accurate for FY92.

2. Quality tradeoff parameters. The recruiting cost screen also allows the analyst to change the assumed tradeoff between high quality and other recruits. EPICC will automatically recalculate the underlying enlistment supply function parameters.

3. Resource prices and fixed recruiting costs. Base year values for these prices can be changed in the recruiting cost screen. To estimate projection year costs in then-year dollars, EPICC inflates the recruiter price using the MPA inflation rate, advertising using the OMA rate, and fixed recruiting costs using an average of the MPA and OMA rates.

4. Market factors. The unemployment and relative military pay assumptions by projection year are the same as those used to adjust reenlistment rates.

5. Contracts. The projected number of high, medium and low quality contracts to be used in estimating recruiting costs are generated by the inventory module.

To facilitate the evaluation of alternative supply elasticities, quality tradeoffs, and resource prices, a pop-up screen accessed from the primary recruiting cost screen duplicates the information in Table 2, showing the optimal resource mix and costs associated with new parameters for FY92 for comparison with the actual results.

Output. The cost function generates the following items for each projection year in an EPICC run:

1. Total recruiting costs, by appropriation. Total costs are given by the following equation.

$$C_T = \Sigma_i\left(p_i R_i^*\right) + A_H \Sigma_j I_j^* + C_r \qquad (33)$$

These total costs are allocated by appropriation as follows:

- Advertising: OMA
- Recruiter costs: MPA and OMA in proportion
to base year appropriation shares
- Enlistment bonus: MPA
- Army College Fund: MPA
- Fixed recruiting costs: Base year MPA/OMA
shares

2. Minimum-cost resource/incentive mix, including the number of production recruiters, the amount of advertising, the average enlistment bonus, and the average value for the ACF.

Reenlistments

The primary cost associated with reenlistments is the Selective Reenlistment Bonus (SRB). The value of an SRB is determined by the formula in equation 34. As the SRB award level

$$SRB = award\ level \cdot monthly\ base\ pay \cdot years\ of\ obligated\ service$$

$$(34)$$

is set by MOS and by years-of-service zones (corresponding to the first through third reenlistment decisions), the average cost of an SRB per reenlistment will vary by skill and YOS.

To calculate the average SRB payment for soldiers in a particular YOS, we use the award levels specified by the analyst in defining the compensation scenario, average monthly base pay (calculated from the pay tables and the grade distribution projected from the inventory module), and the average reenlistment term assumed by the analyst in defining the inventory projection scenario. The average SRB payment is

divided between current and future year costs using the lump sum/installment distribution specified for the compensation scenario. If the lump sum percentage is 50%, for example, half of the SRB payment is applied against the number of reenlistments projected by the inventory module for the current year in the particular occupation and YOS. The remaining SRB payment divided by the number of years in the reenlistment term (minus one) is applied against projected reenlistments in the future years.

For any projection year and occupation, total SRB costs are the sum of the lump sum and installment payments (from pervious years) for all years of service.

Permanent Change of Station

To estimate PCS costs, we define cost factors by type of move -- accession, separation, training, rotational, and operational -- and grade. We outline the calculation of these factors by type of move, noting how each is applied to the inventory projection results.

Accession. The cost factor for accession moves is the average cost per accession move.[25] We apply this factor against the number of accessions in a projection year.

Separation. The cost factors for separation moves equal the estimated average costs per separation move by grade. We use weight allowances by grade to expand the all-Army average cost of a separation move into a per-grade cost,

$$AC_j^{SEPM} = \frac{AC^{SEPM} \, WA_j}{\sum_j WA_j \cdot \frac{S_j}{S}} \qquad (34)$$

where AC^{SEPM} is the Army average cost of a separation move, WA_j is the average weight allowance in grade j, and S_j and S are the grade j and total baseline strengths, respectively.[26] The expression in braces is an index formed by dividing the average weight allowance in grade j by the average weight allowance for

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[25] Per-move average costs, by type of move, are available from ODCSPER.

[26] For equations 33, 34, and 35, we recognized that a better estimate can be calculated based on the distribution of the population appropriate for each equation; however, we did not have access to this data by MOS.

the entire enlisted force.[27] The cost factors for separation moves are applied against the by-grade separations projected by the inventory module.

Training. The training move cost factors are defined as the average cost of a training move by grade. They are calculated in an analogous fashion to the separation move factors, so that

$$AC_j^{TRNM} = \frac{AC^{TRNM} \, WA_j}{\sum_j WA_j \cdot \dfrac{S_j}{S}} \tag{35}$$

where AC^{TRNM} is the Army average cost for a training move. Training cost factors will be applied to training events which, as described below, will be estimated in the cost module by summing the number of promotions in a projection year to grades requiring additional training.

Rotational and Operational. These cost factors, unlike the previous ones, are defined as the average cost of rotational and operational moves *per soldier* in a particular grade. In calculating CONUS and OCONUS moves the key assumption is that operational moves are generated as a residual, after moves out of CONUS fill the empty OCONUS positions and separations are accounted for. This means that the average cost of a rotational move can be expressed as

$$AC_{jk}^{ROTS} = AC^{ROTS} \left[\frac{WA_j}{\sum_j WA_j \cdot \dfrac{S_j}{S}} \right] \left(\left(\frac{2OC}{TL^{oc}} \right) - [OC(1 - c_j)] - OC(Acc) \right) \tag{36}$$

where AC^{ROTS} is the Army average cost of a rotational move. As before, the term in brackets adjusts the Army average for different weight allowances by grade. The final term in parenthesis is the expected number of rotational moves per soldier. The per capita moves required to move members from overseas and to replace those departing overseas is given by two times the proportion of members stationed overseas, $2OC$, divided by the expected OCONUS tour length, TL^{oc}, less the per capita moves required to rotate members who will be separating from the Army, the second term in brackets, less a percentage that represents accession moves to OCONUS positions, $OC(Acc)$, where

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[27] The average weight allowance by grade is calculated using the current weight allowances and the proportions of soldiers in each grade who do and do not have dependents. Weight allowances can be altered by the EPICC user. As described in the pay and allowances section, the dependents status information will come from the baseline year, unless it is modified by the user.

Acc is the percentage of the total force that are accessions. The per capita moves value for those members whose OCONUS tour has ended is achieved by multiplying the proportion of members stationed oversees by the average continuation rate, c_j, to avoid double counting moves associated with separations.

The average cost of an operational move per member is then calculated as

$$AC_j^{OPS} = AC^{OPS}\left[\frac{WA_j}{\sum_j WA_j \cdot \frac{S_j}{S}}\right]\left(\left(\frac{1-OC_k}{TL_k^c}\right) - \left[\frac{OC_k}{TL_k^{OC}} - OC_k(1 - c_{jk})\right] - (1-OC_k)(Acc)\right)$$

(37)

Where AC^{OPS} is the Army average cost of an operational move. The second term, in brackets, is the expected value of making an operational move, which equals the per capita moves required to fill CONUS positions (the proportion of CONUS members divided by the average CONUS tour length, TL^c), less the number of positions that will be filled by members rotating back from OCONUS, the second term in brackets, and less the proportion of those accession moves made to CONUS positions . Both the rotational and operational move cost factors will be applied against the projected number of soldiers by grade.

Default values for the proportion of soldiers stationed overseas and the average CONUS and OCONUS tour lengths derived from baseline year data will be supplied with the model, but the analyst can change these assumptions and thereby alter the rotational and operational cost factors.

Training

Training costs consist of all the variable costs of individual training included in the following categories:

1. **Recruit Training.** An eight week introductory and combat survival skill training course given to enlisted personnel upon their initial entry into military service. This category also includes training to prior service personnel in need of refresher training.

2. **Initial Skill Training.** Includes all formal training normally given immediately following recruit training and leading to the award of a military occupational specialty (MOS) at the lowest level.

3. **One Station Unit Training (OSUT).** Combines recruit training and initial skill training for enlisted personnel in the combat arms and certain combat skills into a single course. Training is conducted at a single station under a single cadre.

4. **Skill Progression Training.** Specialized skill training

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provided to enlisted members subsequent to initial skill
training. Through it the student gains the knowledge to perform
at a higher skill level or in a superior position.

5. **Professional Training.** Noncommissioned Officer
Education System training which is provided on an increasingly
selective basis to noncommissioned officers to prepare them to
perform increasingly complex tasks (e.g., PLDC, ANCOC, BNCOC,
USASMA).

Training cost factors are calculated using the average costs
per graduate for the various courses reported in ATRM-159 (TRADOC
courses) and in a similar cost report produced by the Army Health
Services Command for medical courses. These reports display
calculated course costs based on Instructor Contact hours,
student load, costs of supplies, ammo and the flying hour program
and indirect costs based on medical support, base support and
family housing.

Training costs are applied to the inventory in two ways.
The average initial training cost -- the sum of recruit training,
initial skill training, and OSUT -- will be applied to the total
number of accessions. The costs of advanced training will be
applied to the number of promotions into the grade for which the
training is required. The model uses the following relationship
to calculate training costs.

$$AC_j^{TNG} = \frac{\sum_k AC_{jk}^{GRAD} \cdot SL_{jk}}{\sum_k SL_{jk}} \tag{38}$$

where AC_{jk}^{GRAD} is the baseline average variable cost of training per
graduate from courses in MOS k and grade j. The variable SL_{jk} is
the student load for courses given in MOS k and grade j.

Separation Costs

Separation payments are made to a soldier upon separation
from the Army. There are three types of separation benefits that
service members may receive, depending upon their qualification.
These benefits are:

(1) Accrued Leave. Each service member that is separated
from the Army is entitled to receive payment for the amount of
unused leave she or he has accumulated.

(2) Involuntary Separation. Any member forced out,
regardless of when he or she entered the service, who has been on
active duty at least six years receives a one-time, lump-sum
payment. If a member is not qualified for retention -- e.g.,
QMP, overweight, past a RCP -- she or he may receive only a
partial payment. Those members separated for misconduct are not

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eligible for separation pays.

(3) *Voluntary Separation.* The services are offering bonuses to selected members with between 6 and 18 years of service as an incentive to leave active duty voluntarily. The bonuses may be offered to members who have more than six years active service as of December 5, 1991. Members may choose between an annuity (VSI) or a lump sum (SSB). This program is effective through FY95.

EPICC makes calculations for two types of costs applied to these categories of separation - separation incentive costs and other separation costs.

Separation Incentive Costs. To calculate the cost of providing separation benefits to members, we first calculate the cost of each of the three types of payments. Either the payment is a lump sum or it is an annuity. To calculate the cost of the lump sum payment, regardless of the reason for separation, we use the calculation

$$Pmt_{cij}^{lump} = i(rate_c^{lump})(loss_{ci})(12BP_{ij}) \qquad (39)$$

where i equals a member's YOS, index c indicates the category of separation (i.e., c = 1 indicates voluntary separation, c = 2 indicates involuntary separation with eligibility for full benefits, and c = 3 indicates involuntary separation with only partial payment authorized), $rate_c$ is the percentage of basic pay used depending on the category of separation ($rate_1^{lump}$ = .15, $rate_2^{lump}$ = .10, $rate_3^{lump}$ = .05, and $rate_1^{ann}$ = .025 for each YOS), $loss_{ci}$ is the number of losses experienced in category c by members in YOS i. $12BP_{ij}$ is the annual basic pay for a member in YOS i and grade j.

To estimate the net present value of providing an annuity to eligible members voluntarily separating, we use the following calculation:

$$Pmt_{cij}^{ann} = \sum_{n=1}^{2i}\left[\frac{i(rate_1^{ann})(loss_{ci})(12BP_{ij})}{(1+r)^n}\right] \qquad (40)$$

where n is the year that the annuity is paid, minus the current year, and r is the annual discount rate (.10).

The user has the choice of specifying an incentive program with either a lump sum or an annuity. EPICC will only model one program at a time. Depending on which type of payment is in effect, EPICC calculates the total cost of separation incentives by multiplying either the value for Pmt^{ann} or Pmt^{lump} by the calculated number of Incentive Program "takers".

Other Separation Pay. (Lump sum leave payments plus

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severance/disability pay plus separation move). To determine the cost of separation for all other service members, the following calculations apply.

a. When a service member leaves the service, the member is authorized to cash in any unused leave at the rate of basic pay to which he or she is entitled at the time of separation. The average cost of the lump sum leave payment is calculated by multiplying average number of months leave accrued for each grade by base pay by the probability of separation.

$$AC_j^{leave} = AC_j^{bp} \cdot AML_j \cdot p_s \qquad (41)$$

b. Some service members are also authorized severance pay for disability retirement. The average cost of disability severance is calculated by dividing the total severance pay by the total number of all separatees by grade.

$$AC_j^{sev} = \frac{Sev_{tot}}{\left[\dfrac{AML_j}{AML_{tot}}\right]E_j} \qquad (42)$$

c. Average cost for other separation pay is the sum of the above costs.

$$AC_j^{OthSep} = AC_j^{leave} + AC_j^{sev} \qquad (43)$$

To calculate the total cost of other separation, the model multiplies the above per capita cost by the total number of losses by YOS as calculated by the model for each projection year.

Other Costs

In addition to the cost elements described above the cost data base will include the following cost elements:

1. Retired Pay Accrual provides the funds for DoD's contribution to its military retirement fund under the provisions of 10 USC 1466 of the FY 1984 Defense Authorization Act, P.L. 98-94. Under the accrual concept (effective in FY85) each Service budgets for retired pay in the Military Personnel account and transfers funds on a monthly basis to the Military Retirement Trust fund from which payments are made to retirees. Per capita retired pay accrual cost is determined by multiplying basic pay by a fixed normal cost percentage rate obtained from the DoD

actuary.[28]

2. Medical Benefits consists of all fixed and variable nonpay costs that provide health care to the soldier and his family. It includes the Civilian Health and Medical Program for the Uniformed Services (CHAMPUS) and the care provided by the military hospital system. Health care support costs are broken into two pieces, the cost of CHAMPUS and the cost of care in the military hospitals. CHAMPUS costs will vary as a function of family size and age of dependents. Family size tends to vary directly with grade. Average cost, then, is estimated by using the total government cost for CHAMPUS (inpatient and outpatient care) divided by total number of user beneficiaries (dependents of active duty sponsor). This gives us average cost per beneficiary and can be multiplied by the average family size per grade to determine average CHAMPUS cost per grade. Military health care support costs are a function of the size and number of military hospitals and the medical force structure. These are costs the Army would incur regardless. The model determines the average cost per eligible person by dividing the total hospital operating costs by the number of eligible persons. This is multiplied by the average family size by grade to obtain a per capita cost by grade.

3. Special Pays include hazardous duty, sea/foreign duty, diving duty, overseas allowances, language proficiency pay, family separation allowance, and special duty assignment pay. Special duty assignment pay is authorized only for a selected population of enlisted members assigned to demanding and/or duties with higher degree of responsibilities such as special forces or recruiting assignments and overseas extensions. The model will include the per capita average cost of special pays by grade and occupation.

4. Other Benefits consist of all fixed and variable costs that provide miscellaneous benefits. It includes death gratuities paid to beneficiaries of military personnel who die on active duty, apprehension of deserters, unemployment compensation paid to eligible ex-servicemen,[29] survivor benefits paid to spouses and children of deceased service members, family separation allowance, clothing allowances, benefits provided under the MWR program, and government contribution to social security tax. Average cost of other benefits are determined by

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[28] This cost factor will be recalculated based on user input for each of the variables listed in paragraph 3.2, Appendix A, under retirement benefits; benefits accrual rate by YOS, type of COLA, and number of years is included in the salary base.

[29] In a downsizing environment, applying unemployment compensation factors to manyears as opposed to losses will ultimately underestimate unemployment costs; however, the effect will not be seen for several projection periods.

dividing their total cost in the baseline year by the total number of soldiers in the inventory in the same year.

All of the cost factors associated with the Other Costs category are percapita costs that will vary only according to changes in manyears and adjustments for any inflation. All of the cost factors described above will be applied to the projected inventories calculated by the inventory projection module.

Other Features of the Cost Estimation Process

The EPICC model provides the user with two additional features for limited modification of the cost factor data base. The user may select/deselect each of the cost elements so that an analysis may focus on a specific cost element or group of cost elements. Second, the user has the option of specifying inflation rates that vary by budget appropriation and projection year. Positive inflation rate assumptions will provide budget costs in then-year dollars for each of the projection years.

Table 4 summarizes all the cost factor assumptions the user may modify by dimension.

Table 4.

User Accessible EPICC Cost Module Variables

Cost Element	Variables	Dimensions
Military Compensation	- Base Pay - BAQ/VHA - BAS - % w/dependents - % getting BAQ-in-cash	gradexYOSxproject yr(PY) gradexPY gradexPY gradexPY gradexPY
Retirement	- Multiplier for 20 YOS - Multiplier for 30 YOS - Multiplier for age 62 - No. years in base - Non-pecuniary benefit - Portion of COLA used - Entry year	
PCS	- Weight Allowance - Avg cost PCS move - OCONUS tour length - % OCONUS - CONUS tour length	gradexdepndt status move category
SRB	- Bonus multiplier	zonexMOSxPY
Recruiting	- Resource prices for: -- Recruiters -- Advertising -- Avg MEPS cost - Fixed Cost - Elasticities for: -- Recruiters -- Advertising -- Enlistment Bonus -- Education Benefits -- Unemployment -- Rel Military Pay - Recruiter tradeoffs	
Separation Incentive	- Designation as lump sum or annuity - No. years of annuity - Non-pecuniary benefit - Projection year - Separation eligibility - Separation elasticities	MOSxYOS YOSxPY

Cost Module Output

The cost estimation module will store the cost factors in a structured cost data base. The user will be able to view the detailed cost factors in the data base before applying the factors to the inventory projections. If the user wishes to change the assumptions underlying the cost factors, he or she will rerun the appropriate cost equations, generating a new structured cost data base.

Summary costs are obtained by applying the cost factors to the projection results. These costs will include a total enlisted force cost by projection year, plus total costs disaggregated by grade, cost element, and budget appropriation.

Summary

The EPICC cost estimation module gives the personnel analyst the significant added capability of understanding the budget as well as inventory implications of alternative personnel policies. This module is based on the budget model in the Army Manpower Cost System, with modifications that capitalize on the detailed inventory data available in EPICC to provide better budget estimates. The cost estimation methodology we have specified has the following features:

1. Cost factors for most of the significant cost elements are determined by modeling the Army's personnel system, rather than simply averaging last year's costs. This allows the user to adjust the cost factors for policy changes.

2. In addition to a bottom line, the cost estimation module will provide costs disaggregated by major cost element and appropriation, aiding the analyst in understanding why a given policy has its particular cost implications.

3. Because of the similarity between the EPICC cost estimation module and AMCOS, updates of cost data and improvements to the AMCOS policy modules can be incorporated into EPICC with little modification. The similarity also means that the extensive AMCOS user community will be able to easily understand and utilize the cost estimation functions in the EPICC model.

The next chapter describes the technical requirements for the model.

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TECHNICAL REQUIREMENTS

EPICC is a user-friendly, high speed computer model requiring moderately sized hardware with no special modifications. The model will run on the equipment currently available to the Army DCSPER Staff. This chapter discusses the model's processing requirements, hardware requirements, and the user's interface.

Data Processing Requirements

We have built EPICC around a set of data structures that allocate the computer's memory for storage of data elements. These data elements include user inputs, other inputs, intermediate results, and outputs. The dimensions of these data elements vary, but most are dimensioned by SUBINVENTORY(25), YOS(31), and GRADE(8), for a total of 6200 cells per element.

Overall, EPICC uses about 40,000 cells or 160 kilobytes (k) of computer memory to store data. EPICC's programming code and executive "shell" (windows and menus) consume an additional 250k. The entire EPICC system then, requires about 410k. The DOS operating system allows access to a maximum of 640k of memory, of which about 100k is usually used by DOS itself and other programs. This leaves about 540k available for running applications like EPICC. Because EPICC currently requires 410k, it fits well within the memory normally available through DOS on an IBM PC. However, the use of any memory resident software could degrade the performance of the model.

Hardware Requirements

The EPICC model requires the following minimum configuration to run efficiently:

1. An IBM compatible PC with at least 640k bytes of RAM;
2. A math co-processor;
3. A large hard disk (at least 20mb of unused, available space).

In addition, we recommend that for each office using the EPICC model, a single machine be dedicated to the EPICC project. This configuration allows each office to make multiple runs of the model and still retain the output on the PC. A large hard disk is required to store the model's large amount of output which is written to ASCII files as opposed to binary files. The ASCII format allows the user to easily import the output files to a spreadsheet or graphic's package for further analysis.

User Interface

We have incorporated a number of features in the EPICC model to make it very user-friendly. The model gives the user a completely self-contained analytical tool. It features a menu-based operation, a default set of scenario assumptions, a

scenario editing capability, automatic file maintenance, and a
set of on-line help screens. Each are further discussed below
and a full discussion is included in the EPICC User's Manual.

Menu Based Operation

The user is able to
operate the EPICC model through
a system of menus combined with
the extensive use of function
keys. For example, through
these menus the user is able to
specify scenarios, choose
calculation options, and select
output formats. By making use
of function keys the user will
be able to initiate common
functions with the stroke of a
single key.

The menus are set up so
that the user can define a run
scenario for the whole model
and then operate either the
inventory projection module,
the cost module, or both (see
Figure 5). When the user
selects the option to define
the run scenario, he/she will
be guided through data entry.
The user will be able to input
data for inventory projection,
the compensation-retention
link, or cost estimation (see
Figure 6). Each of these menu
items leads the user to
additional screens that contain
the full set of data files.

Figure 5.   EPICC Main Menu

Figure 6.   Define Scenario Main
Menu

Default Scenario Assumptions

EPICC is a complex
personnel projection,
compensation and cost model with the flexibility to vary just
about any underlying variable. As a result of this flexibility,
there are a large number of screens that contain the scenario
assumptions for a given run. To simplify the initial data input
to these screens, the model comes with a complete set of default
assumptions based on historical data. In most cases the analyst
will only have to change the small number of assumptions that
apply to the issue being evaluated. To make those changes the
user simply has to call up the appropriate screen and edit the
default data. An example of the default reenlistment rates is
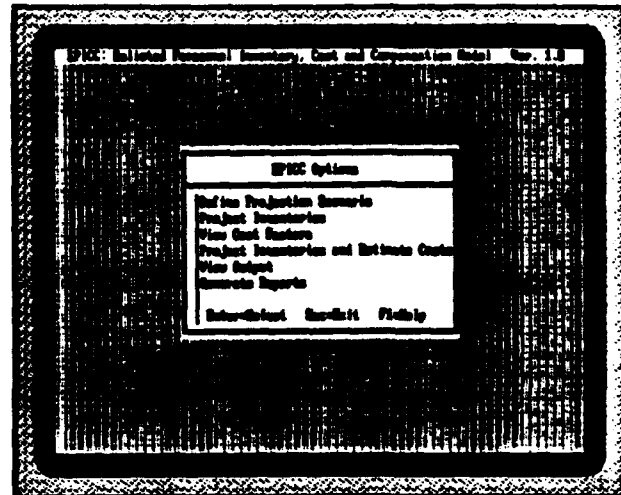shown in Figure 7.

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Scenario Editing

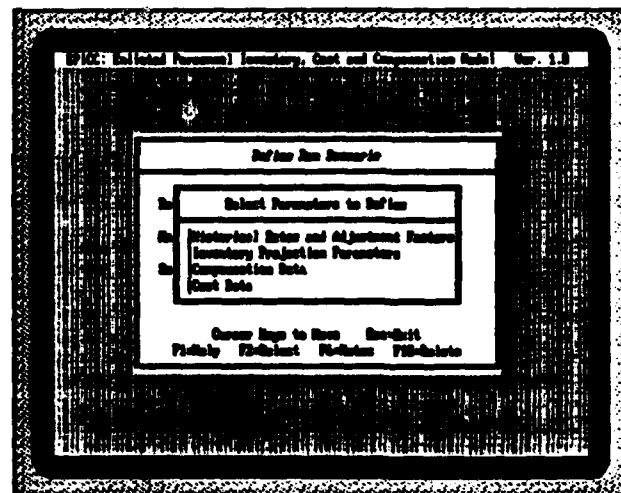As we have already pointed out, the flexibility of the EPICC model requires a large volume of underlying data that the user might want to edit for any given scenario. In some cases the user may need to replace large pieces of the default data. To reduce obvious input errors normally associated with inputting large volumes of data, the user interface will check assumptions on entry and, if necessary, will prompt the user for a correction.

Figure 7. Default Reenlistment Rates

If the user changes any assumptions that require a change elsewhere in the data, the user interface will prompt the user for the additional entry. We have also structured the scenario screens according to which module they are predominately tied to. For example, pay and allowances assumptions feed both the compensation-reenlistment module and the cost estimation module, but they are primarily tied to the compensation-reenlistment module and are accessed through the "Compensation Data" menu item.

Automatic File Management

In many cases a change to data in one part of the model will trigger a recalculation in another part of the model. To ensure that these recalculations are done, the storage and retrieval of all data and results files will be automatic and invisible to the user. For example, when the user inputs changes to the baseline pay tables, the model will automatically update the costs and the retention rates.

On-line Help Screens

To provide the user with easily accessible help, EPICC will contain imbedded documentation to help the user during operation of the model. The help screens are designed to provide the user with a discussion of the part of the model being used at the time. For example, if the user is modifying reenlistment rates, the F1 key will provide a pop-up screen with a complete discussion on reenlistment rates, how they are applied in the model, and what impact a change might have. If this discussion does not answer the problem, an SRA phone number will also be provided. This set of on-line helps compliment the written documentation (user's manual) that will be provided with the model.

The next chapter discusses the validation of the inventory projection and cost estimation capabilities of EPICC.

MODEL VALIDATION

We validated both the inventory projection and cost estimation capabilities of the EPICC model by performing an out of sample prediction for FY93. Inventory and cost estimations were made using ex post information for the input variables so that validation was able to focus on the estimation methodology. We did not want to confound the estimation problems with difficulties in estimating values of what are essentially covariates.

Our approach to validating EPICC inventory and cost estimating methodologies entailed comparing EPICC inventory predictions for FY93 with the FY93 actual values obtained from the September 1993 Final Update run of ELIM-COMPLIP (Alternative Number E930950P). The predicted costs from EPICC were compared to the FY93 column of the FY94 President's Budget.

Assumptions

The following paragraphs present the assumptions we used to validate EPICC. They are grouped into assumptions about inventory projection, the economy, recruiting, and separations.

Inventory Projection Assumptions

The following assumptions were made regarding personnel policies and selected gains and losses.

- QMP Losses for FY93 equal 1,440 and the Army expects no forced losses

- EPICC has no category for soldiers who are returned to military control (RTMC) and reserve component (RC) accessions; therefore, the model adds 1,437 (RTMC) and 159 (RC) to the 7,732 PS accessions and treats the total as PS accessions

- Retention Control Points (RCPs) are as stated in Chapter 4, AR 600-200; however, EPICC does not model retention of soldiers in a promotable status

- Promotion rates are not constrained to a minimum

- PCS tour lengths for CONUS are assummed to be 3.2 years and OCONUS is assummed to be 1.9 years with 1/3 of the force in OCONUS

Economic Assumptions

The following table reflects the economic environment for FY93.

- Civilian pay will increase by 2.4% in FY93

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- Unemployment is assummed to be 6.7%

- Inflation applied to all appropriations is 2.4%

- The average personal discount rate is 10%

- Consumer price index growth is 2.4%

Recruiting Assumptions

The recruiting module in EPPIC is separate from the other AMCOS output and estimates recruiting costs based on the following assumptions.

- The recruiting cost function describes the *minimum* costs associated with achieving a given recruiting mission specified by quality level. It is based on the actual recruiting experience of FY90 which is described by the following parameters:

  - High Quality Accessions were 63,000; Medium Quality Accessions were 1,100; and Low Quality Accessions were 25,200. (These were number of contracts)

  - "Foxhole" recruiters used were 5,700

  - Cost of advertising was $55.6M

  - The average enlisted bonus was $935

  - The average value of educational benefits was $272

  - The fraction of contracts that were DEP losses (i.e., they were not accessions) is 0.15

- We also assummed the following supply elasticities

  - Recruiters is 0.25

  - Advertising is .05

  - EB is 0.07

  - Ed Benefits (vis-a-vis the accrual value) is 0.03

  - Low Quality tradeoff is 1 to 6

  - Med Quality tradeoff is 1 to 2

  - Relative military pay is .80

  - Unemployment is .70

Separation Assumptions

We assummed that a separation incentive policy would be in effect in FY93. The program is assummed to be a single VSI/SSB program and is modeled in EPICC as an SSB policy (most takers of the separation incentive have chosen the SSB). The following assumptions apply:

- The eligible populations are in YOS 6-17 for the following MOS: 12C, 14D, 16D, 16E, 23R, 24H, 24K, 24N, 24R, 25L, 27B, 27F, 27G, 27H, 27J, 27K, 29J, 29N, 31C, 31M, 31N, 31Y, 39D, 42C, 55G, 63B, 67N, 74C, 74D, 74F, 91M, 97E, 98G

- To account for eligibles by grade we further refined the YOS dimension by using the following grade surrogates[30]

  - E-5s are assumed to match up with YOS 6-12

  - E-6s are assumed to match up with YOS 10-20

  - E-7s are assumed to match up with YOS 14-20 (after 20 YOS, losses are counted as retirements)

- The lump sum payment is calculated as 0.15*YOS*Base Pay

- We assumed a value of $1500 for non-monetary benefits (e.g., three months worth of medical, PX, commissary)

Validation Results

The model was run using the above stated assumptions and the output was then aligned with the FY93 actuals. As can be seen in Table 5, the EPICC reenlistment rates are accurately predicting reenlistments.

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[30]The software has since been modified to accept a grade dimension from the user.

Table 5

ELIM-COMPLIP FY93 Actual Losses and EPICC FY93 Projected Losses

ELIM-COMPLIP (FY93 actuals)		EPICC (FY93 projected)	
Immed Reenl	73,906	Reenlistments	71,935
Retirements	12,608	Normal Losses >20 YOS	6,876
Early Retire	256	SERBs	0
ETS Losses	43,312	Normal Losses <20 YOS	73,249
Adverse Losses	20,981	RCPs	1,092
Other Losses	33,077	RIFs	0
(VSI/SSB Takers)	4,755	QMPs	1,440
		NPS Attrition	8,194
		(SSB Takers)	4,807

Since the ETS losses are a complement of the reenlistment rate, we can safely assume that the ETS losses are being accurately predicted as well (EPICC includes ETS Losses in the total for Normal Losses). The separation incentive module is also accurately predicting the number of VSI/SSB takers.

NonETS losses are predicted with less accuracy. The model is predicting about 50% of the actual numbers of retirements, which we believe is due to the overall impact of the downsizing on losses in general. It is also underestimating adverse losses due to the same thing. Because of the turbulence being experienced by the Army during these past few years, more than the expected number of personnel are retiring. If soldiers are not eligible for retirement, they are using other means to be honorably released from the Service. Note the large number of losses in the "other" category from ELIM-COMPLIP. This category of losses includes all the administrative losses such as compassionate discharges, failure to meet Army weight standards, and separation for convenience of the government. With the model underestimating losses in general, it follows that the estimated value for NPS attrition will be low as well. However, that number will increase if the number of retirements and nonETS losses were to be increased.

Predicted gains are compared to actuals in Table 6. PS accessions match exactly because they are a direct user input. The NPS accessions are underestimated, but that is because overall losses are underestimated. With increased losses to match the actuals, EPICC will predict the appropriate number of accessions. (In fact, we reran the model with retirements and nonETS losses increased to compare favorably with actuals, and the number of NPS accessions equaled 70,000).

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Tables 6

ELIM-COMPLIP FY93 Actual Gains and EPICC FY9? Predicted Gains

ELIM-COMPLIP (FY93 actuals)		EPICC (FY93 predicted)	
Immediate Reenl	73,906	Reenlistments	71,935
NPS Accessions	70,080	NPS Accessions	51,961
PS Accessions	7,732	PS Accessions	9,328
RTMC	1,437		
from RC	159		

Finally we compare predicted costs with FY93 estimated costs as contained in the FY94 President's Budget.[31] As can be seen in Table 7 below, the estimates are reasonably close. In Table 8 we focus on recruiting costs using data from USAREC. Because the Army maintains a minimum level endstrength of recruiters in anticipation of surges and because EPICC costs out optimally allocated recruiting resources (see Appendix C), the number of recruiters estimated by EPICC is relatively low while the estimated use and cost of bonuses, educational benefits, and advertising are relatively high. These differences offset each other and we find that the total cost estimate of the program is close to USAREC's figure, as is the estimated number of contracts.

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[31]This validation was conducted in late November 1993 and FY93 actual costs were not available at that time.

Table 7

Comparison of the FY94 President's Budget (FY93 Costs, $000) with
EPICC Predicted Costs

	FY94 PB	EPICC	% Difference
Basic Pay	7,944	7,979	.44%
Retired Pay	2,892	2,904	.41%
BAQ/VHA	1,206	1,008	-16.42%
BAS	778	772	-.77%
SRBs	65	80	23.08%
PCS	790	789	-.13%
Special Pays	568	525	-7.57%
Other	1,364	1,142	-16.28%
VSI/SSB	262	217	-17.18%

Table 8

Comparison of FY93 Actual Costs for Recruiting with EPICC Predicted
Costs ($M)

	FY93 Actuals[32]	EPICC Predicted
Number of Recruiters	4700	2723
Total Enlisted Bonus	11.5	21
Total Educational Benefits	8.6	22
Advertising	32	15
Number of Contracts	80300	81484
Total Cost	512	484

The next chapter discusses our conclusions.

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[32]Source: U.S. Army Recruiting Command.

CONCLUSIONS

Single Integrated Tool for Personnel Policy Analysis

EPICC assists Army personnel planners in their assessment of the cost and inventory implications of the alternative Army-wide policies that may be under consideration. It is the ideal tool for this purpose because it is composed of three modules that do the following:

1. <u>Inventory projection module.</u> The inventory projection module predicts how the inventory of the Army will change over time as individuals enter and leave the force under different Army-wide personnel policy scenarios. The inventory model also predicts losses, determines accession requirements, and identifies changes in the composition of the enlisted force.

2. <u>Cost estimation module.</u> Any change in personnel policies has cost as well as inventory implications. The cost estimation module determines the budget cost of a particular inventory by applying appropriate cost factors to the stocks and flows associated with the inventory.

3. <u>Compensation-retention module.</u> Changes in military compensation affect reenlistment rates, which are the key input in assessing the year-to-year losses from an inventory. The compensation-retention module provides the quantitative link between compensation policy changes and reenlistment rates while controlling for differences between demographic groups.

EPICC provides the Army for the first time, a single model in which inventory, cost estimation, and compensation-retention modules are linked. This advantage significantly improves decision-making since the analysis of multi-dimensional issues often requires the interaction of the three activities described above. Therefore, the integration of these three personnel analysis tools in EPICC facilitates the complete evaluation of policy alternatives by eliminating the often difficult task of working with three different, and sometimes inconsistent, models.

A Valuable Training Tool

EPICC can be run quickly and easily. This lends itself to using the model as a training device for all new personnel policy analysts being assigned to the ODCSPER staff. New analysts will be able to learn to operate EPICC easily. Then, by running several scenarios, an analyst can quickly learn how various policy parameters impact on the enlisted force. We believe that EPICC will facilitate the process of learning the Army's personnel system. In this way the model will fill a definite need on the Army staff.

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APPENDIX A

DISCUSSION OF COST POLICY MODULES

This appendix contains an extract of the AMCOS Information Book which explains the methodologies used to calculate costs. This extract does not include a discussion of recruiting costs since EPICC is using the methodology described in Appendix C.

CHAPTER 3
DISCUSSION OF COST POLICY MODULES

3.0 CHAPTER INTRODUCTION

The sections of this chapter discuss the AMCOS policy modules individually. Each section may contain the following information:[1]

- Cost Composition - A discussion of the specific policy that generates the manpower cost.

- Average Cost Computation - A discussion of the methodology used to calculate the average cost for a specific policy. In most cases you will want to use average costs to estimate the life-cycle costs of a weapon system.

- Marginal Cost Computation - A discussion of the methodology used to calculate marginal costs. Marginal costs are used when using the budget analysis to evaluate changes to the budget.

- Discussion - A general discussion of the policy module calculations.

- Notation - Lists the definitions of variables used in the text.

- Structured Cost Database Variables - Lists the definitions of variables as seen in the structured cost database.

- Underlying Variables - *Lists the definitions of variables as seen in the underlying database. You need not be concerned with these variable definitions unless you will be maintaining the AMCOS models' software.*

The current list of policy modules includes:

- Military Compensation

- Enlisted Recruiting

- Officer Acquisition

- Training

- Permanent Change of Station

- Retired Pay Accrual

- Selective Reenlistment Bonus

- Separations

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[1]This same information is embedded in the AMCOS software and can be accessed through the Help menu.

- Special Pays

- Medical Support

- Other Benefits

- The New GI Bill

With the exception of the Selective Reenlistment Bonus, Recruiting, and Training policy modules, marginal costs are assumed to be equal to average costs. Therefore, in-depth discussions regarding marginal cost calculations may be absent from the remaining policy module sections.

3.1 MILITARY COMPENSATION

COMPOSITION: Consists of all variable costs that provide Basic Pay, quarters (BAQ) and subsistence (BAS) allowances, and variable housing allowances (VHA).

- Basic pay is defined as a direct variable cost that provides basic compensation and length of service increments for members on active duty. The amount of basic pay a member receives is a function of pay grade and length of service.

- Basic Allowance for Quarters (BAQ) is paid to military members who do not occupy government housing or who occupy government housing that is not adequate. There are two rates: one for "with dependents" and one for "without dependents." The cost of providing BAQ varies with grade and category of dependents. Members who reside in quarters, on the other hand, receive BAQ-in-kind.

- Basic Allowance for Subsistence (BAS) represents both the cost of food for personnel eating in government messes and the cash payments to military members in lieu of food. BAS varies as a function of the number of people receiving cash in lieu of mess privileges and the cost of food to DoD. To properly cost BAS, the model should include the cost to the government for food. For this iteration of the model, however, we will assume that the average cost to the government for providing rations is equal to the BAS rate.

- Variable Housing Allowance (VHA) is paid to military members receiving BAQ whose families reside in high cost housing areas of CONUS. Cost varies as a function of the number of member families residing in high cost areas in CONUS, the cost of local housing relative to BAQ rates, and the pay grade. For the purposes of this model, however, a weighted average across all locations is used.

AVERAGE COST: Average basic pay is determined by first multiplying the inventory of members[2] for all grades and YOS by the appropriate basic pay rate. It is then summed across YOS for each pay grade and divided by the total inventory for that pay grade. This yields the average annual basic pay for each pay grade. The longevity increments for a grade are weighted by the inventory in that grade.

To calculate average BAQ assuming all members receive BAQ in cash, the model multiplies the BAQ rates, both with and without dependents, by the percentage of members in each grade with and without dependents. The sum of these two numbers is the average BAQ for that pay grade.

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[2] All inventories reflect Army strengths as of September 30, 1992.

$$(3.1) \qquad AC_j^{bp} = \frac{\displaystyle\sum_{i=1}^{30} bp_{ij} \cdot E_{ij}}{\displaystyle\sum_{i=1}^{30} E_{ij}}$$

$$(3.2) \qquad AC_j^{baq1} = (w\_dep\%)(bq1_j) + (1-(w\_dep\%))(bq2_j)$$

We use the average VHA by grade as calculated in the MPA Budget Justification Book, which records the average rate of VHA actually paid to members.

$$(3.3) \qquad AC_j^{vha1} = \frac{\displaystyle\sum_{c} E_{cj} \cdot vha\_yr_{cj}}{\displaystyle\sum_{c} E_{cj}}$$

To calculate average BAQ assuming some members receive BAQ-in-kind, the percentages of all members by grade (with and without dependents) who receive BAQ in cash (m_cash and s_cash) are summed. This percentage is then subtracted from unity and multiplied by the percentage of members with dependents to calculate the percentage of members receiving BAQ-in-kind. A similar calculation is used to calculate the percentage of members without dependents receiving BAQ-in-kind. We assume that m_kind + s_kind + m_cash + s_cash equals 1.

$$(3.4) \qquad m\_kind = (1-(m\_cash + s\_cash))(w\_dep\%)$$

$$s\_kind = (1-(m\_cash + s\_cash))(1-(w\_dep\%))$$

The average BAQ, assuming some members receive BAQ-in-kind and some in-cash, is simply the percentage of members by grade, with and without dependents, who receive BAQ in cash multiplied by the BAQ rate.

$$(3.5) \qquad AC_j^{baq2} = (m\_cash_j \cdot bq1_j) + (s\_cash_j \cdot bq2_j) + (s\_kind_j \cdot bq3_j)$$

Similarly, the VHA rate assuming a mix of BAQ-in-kind and cash is the fraction of those receiving VHA multiplied by the average VHA rates.

$$(3.6) \qquad AC_j^{vha2} = fract\_vha_j(vha\_yr_j)$$

Average BAS is determined by calculating the weighted average of all who receive BAS using the information from the MPA Budget Justification Book. To determine total military compensation paid to the member the model simply adds the pieces already calculated.

$$(3.7) \qquad AC^{mc} = AC^{bp} + AC^{baq1} + AC^{vha1} + AC^{bas}$$

MARGINAL COST: Marginal cost of military compensation is equal to the average cost with a maximum rate of VHA per grade being substituted for VHA. The model assumes that at the margin quarters at each installation always will be filled. Rather than calculate an expected location the model will pay VHA at the maximum rate to a new space.

DISCUSSION: The data for military compensation will be extracted from the appropriate OSD pay tables, allowance tables, or RMC/BMC tables, using a pay table look-up procedure. In addition, we have obtained tables of allowances based upon Army-specific data on the number of dependents.

A pay table look-up procedure, as opposed to using a snapshot of the JUMPs file, provides the user with the ability to avoid random fluctuations in the amount of pay received by a member that has nothing to do with his personnel characteristics. In addition it provides the user the flexibility to simply update the pay tables when appropriate so that changes in manpower costs can be reflected immediately. This methodology also allows the user the flexibility of costing a given force under alternative wage scenarios. For example, if pay is assumed to grow at a real rate of 5% per year, the pay table 10 years in the future can be increased to

$$(3.8) \qquad ARC_t + 10 = ARC_t(1 + 0.05)^{10}$$

as specified by the user. To do this, SRA would have to make a special run of this policy module creating a separate cost data file to be used for simulating the alternate wage scenario.

NOTATION:

E_{ij} = Inventory of members in YOS i and grade j

AC^{mc} = Average annual compensation paid to a member

bp_{ij} = Basic pay for an individual member in YOS i and grade j

E_{cj} = Number of members in city C and in grade j

AC_j^{bp} = Average annual basic compensation paid to members in grade j

$bq1_j$ = Rate of BAQ for members drawing w/dependents in grade j

$bq2_j$ = Rate of BAQ for members drawing w/o dependents in grade j

$bq3_j$ = Rate of BAQ for members drawing partial BAQ (single, living in government quarters)

m_cash = % of married, or single with dependents, members actually drawing BAQ in cash

s_cash = % of single members actually drawing BAQ in cash

m_kind = % of married members drawing BAQ-in-kind

s_kind = % of single members drawing BAQ-in-kind

AC_j^{baq1} = Average BAQ for grade j assuming all members receive BAQ in cash

AC_j^{baq2} = Average BAQ for grade j assuming some members receive BAQ-in-kind

AC_j^{bas} = Average BAS for grade j

AC_j^{vha1} = Average VHA for grade j assuming all members receive BAQ/VHA in cash

AC_j^{vha2} = Average VHA for grade j assuming some members receive BAQ/VHA-in-kind

w_dep% = % of members with dependents

fract_vha$_j$ = Fraction of those receiving VHA

vha_yr$_{c,j}$ = Average VHA yearly rate for members in grade j who do not live in government quarters

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_bp	-	Average annual base pay
ac_baq1	-	Average cost of baq paid in-cash
ac_vha1	-	Average cost of vha paid in-cash
ac_baq2	-	Average cost of baq paid in-kind
ac_vha2	-	Average cost of vha paid in-kind
ac_bas	-	Average basic allowance for subsistence
ac_tax	-	Average annual tax benefit
ac_rmc	-	Average annual compensation

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
bp	basic pay by grade and YOS	mcparms.enl	Pay Tables
bq1	BAQ w/dependents	mcparms.enl	MPA J-BOOK
bq2	BAQ w/o dependents	mcparms.enl	MPA J-BOOK
bq3	partial BAQ w/o dependents	mcparms.enl	MPA J-BOOK
bas	basic allowance for subsistence	mcparms.enl	MPA J-BOOK
ginv	grade inventory	enlisted.dat or officers.dat	
inv	inventory (master files)	inv.enl	DMDC
rmc	regular military compensation	mcparms.enl	MPA J-BOOK
vha	variable housing allowance	mcparms.enl	MPA J-BOOK
w_dep%	% drawing w/dependents	mcparms.enl	MPA J-BOOK
m_cash	% w/dep receiving BAQ in cash	mcparms.enl	MPA J-BOOK
s_cash	% w/o dep receiving BAQ in cash	mcparms.enl	MPA J-BOOK
fract_vha	% receiving VHA in cash	mcparms.enl	MPA J-BOOK

3.2 RETIRED PAY ACCRUAL

COMPOSITION: Provides the funds for DoD's contribution to its military retirement fund under the provisions of 10 USC 1466 of the FY84 Defense Authorization Act, P.L. 98-94. Under the accrual concept (effective in FY85), each Service budgets for retired pay in the Military Personnel account and transfers funds on a monthly basis to the Military Retirement Trust fund from which payments are made to retirees.

AVERAGE COST: Retired pay accrual average per capita cost is determined by multiplying the basic pay (determined earlier by grade) by a fixed normal cost percentage rate obtained from the DoD actuary.

$$(3.9) \qquad AC^{rp} = AC_j^{bp} \cdot r_{act}$$

AN ALTERNATIVE ESTIMATE: This next discussion provides an alternative estimate of military retirement pay accrual for Army officers and enlisted personnel. The DoD Actuary estimates an accrual change based upon all-DoD retention rates and retirement probabilities. The computations used in this alternative estimate are based upon Army retention rates only.

There are currently three different retirement systems in effect: (1) for those who entered prior to October 1, 1980, retirement pay is based upon their terminal base pay and is equal to 2.5 percentage points for each year of service (a minimum of twenty years of service is required for retirement); (2) for those who entered after October 1980, but before August 1986, retirement pay is based upon an average of the three highest years of basic pay and is equal to 2.5 percentage points for each year of service; and (3) for those who enter after August 1986, retirement pay is again based upon an average of the three highest pay grades, but is limited to 40% of basic pay after twenty years, rising annually to a maximum of 75% if the member retires after completing 30 years of service.

Under the first two systems, retirement pay is, nominally, indexed for inflation. Under the third system, the member receives an adjustment to his retirement pay that is one percentage point less than a full indexation each year. However, the real value of retirement pay is restored upon reaching age 62. Also at age 62, the member receives the percentage of retirement pay that is offered under the pre-1986 system.

In this policy module option, the retirement accrual is computed using an approximation to the entry-age normal method. Certain simplifying assumptions are made that make this an approximation to the accrual cost. We assume:

- All enlisted personnel enter at age 18;

- All officers enter at age 22; and

- All members live until age T.

Define $P_k(i)$ to be the probability that a member entering MOS k leaves the service after completing i years. It is computed as
where CR_{kt} is the continuation rate for MOS k between the end of year of service t-1 and t. Define BP^i as the average pay attained by those leaving at year of service i.

(3.10)
$$P_k(i) = (1 - CR_{k,i+1}) \prod_{t=1}^{i} CR_{kt}$$

Pre-1980 System. The following computations apply to those who entered before October 1980. The present value of the expected retirement annuity for an individual is:

(3.11)
$$PV_k^R = \frac{\sum_{i=20}^{30} \sum_{t=i}^{T-18} P_k(i)(.025i)(BP^i)}{(1+r)^i}$$

PV_k^R is the present value of retirement for MOS k.

Now calculate the expected present value of basic pay that will be paid out to the member over his career:

(3.12)
$$PV_k^{BP} = \frac{\sum_{i=1}^{30} \sum_{t=1}^{i} CR_{kt} \cdot BP_k^i}{(1+r)^i}$$

The accrual percentage, then, is defined as the ratio of the expected present value of retirement outlays to the expected present value of basic pay over the member's career:

(3.13)
$$A_{k,pre-1980} = \frac{PV_k^R}{PV_k^{BP}}$$

Finally, the accrual amount for a member under the system in effect before 1980 is:

(3.14)
$$AC_{jk,pre-1980}^T = AC_{jk}^{bp} \cdot A_{k,pre-1980}$$

High-Three Averaging. The system in effect for those entering after 1980, but before 1986, is similar to the system just discussed, except that a member's retirement pay is based upon an average of her highest three years of basic pay. Hence, we can simply modify equation 3.11 to read:

(3.15)
$$PV_k^R = \sum_{i=20}^{30} \sum_{t=i}^{T-18} \frac{P_k(i) \cdot .025i}{(1+r)^i} \cdot \frac{1}{3}\left(\frac{BP_k^{i-2}}{(1+w)^2} + \frac{BP_k^{i-1}}{(1+w)} + BP_k^i \right)$$

where "w" is the expected annual basic pay raise, expressed as a decimal.

Post-1986 System. Estimation of the accrual percentage on the new retirement system again requires only a modification to equation 3.11:
The new system offers a retirement annuity of 40% of basic pay after 20 years of service, rising to 75% after 30 years of service. However, the annuity as a proportion of basic pay is increased to what it would have been under the older system after the retired member reaches age 62. The annuity is indexed to one percentage point less than the inflation rate, w. However, the real value is restored

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$$f(t) = \frac{1}{3}\left(\frac{BP_k^{t-2}}{(1+w)^2} + \frac{BP_k^{t-1}}{(1+w)} + BP_k^t\right) \qquad then,$$

(3.16)

$$PV_k^R = \sum_{i=20}^{30}\sum_{t=i}^{61-18} \frac{P_k(i)(.4+.035(20-i))f(i)}{(1+r)}\left(\frac{1+w-.01}{1+w}\right)^{t-i}$$

$$+ \left(\frac{1+w}{1+w-.01}\right)^{62-18-t}\left(\sum_{t=62-18}^{T-18} \frac{P_k(i).025yf(i)}{(1+r)^t}\right)\left(\frac{1+w-.01}{1+w}\right)^{t-62+18}$$

when the retired member reaches age 62. It again increases a one percentage point less than the inflation rate. The retirement annuity is based upon an average of a member's highest three years of basic pay.

DISCUSSION: The default accrual costs estimated in the model are based solely on the OSD Actuary's analysis. She uses the aggregate entry-age normal method. Alternative methods and assumptions produce different costs for the Army. The equations discussed in this policy module option approximate the entry age normal method of retirement accrual used by the DoD Actuary, but with Army specific retention rates. Using the Army specific probabilities of reaching retirement reduces the accrual cost to the Army. The Army could use these calculations to argue for a lower accrual rate than the current overall DoD rate.

These equations permit the use of a retirement accrual percentage that varies by:

- CMF
- Retirement System
- Quality.

NOTATION:

AC_{jk}^r = Average cost per capita of retired pay accrual for grade j and MOS k

AC_{jk}^{cp} = Average annual basic compensation paid to members in grade j and MOS k

r_{act} = Fixed normal cost rate obtained from DoD actuary tables

$CR_{k,t}$ = Continuation rate for MOS k between the end of year service t-1 and t

$P_k(i)$ = Probability that a member entering MOS k will leave after completing i years of service

BP^i = Average pay attained by those leaving at YOS i

PV_k^R = Present value of retirement for MOS k

PV_k^{BP} = Present value of basic pay paid to a member in MOS k over his or her

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career

A_t = Accrual percentage calculated using Army specific retention data

w   = Expected annual basic pay raise expressed as a decimal

STRUCTURED COST DATABASE VARIABLES - Definition

ac_rp   -   Average cost per capita of retired pay accrual
ac_rp_hi   -   Average cost per capita of retired pay accrual-high quality
ac_rp_lo   -   Average cost per capita of retired pay accrual-low quality
ac_rp_av   -   Average cost per capita of retired pay accrual-weighted average

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
inv	inventory	inv.enl	DMDC
BP	base pay	mcparms.enl	PAY TABLES
CR	continuation rates	con_rate.enl	DMDC
r_act	DoD actuary rpa factor	rpaparms.enl	MPA J-Book
hiQual	% high quality accessions by MOS	rechqtot.enl	DMDC

3.3 SELECTED REENLISTMENT BONUS

COMPOSITION: Consists solely of the Selective Reenlistment Bonus. The bonus offer is computed as:

$$SRB = \text{Award Level} \times \text{Monthly Basic Pay} \times \text{Years of Reenlistment}$$

Reenlistment bonuses are offered to members in an MOS on a discretionary basis, at zone A (for our purposes, we assumed that zone A equates to grades E4-E6) and zone B (grades E5-E7). These bonuses correspond to the first and second term reenlistment decision points. The "award level" may vary from zero to six. Currently, 50% of the SRB is paid to the member as a lump-sum at the time of the reenlistment, while the remainder is paid in equal, annual installments over the period of the reenlistment contract.

This computation is concerned with estimating the average cost of Selective Reenlistment Bonuses. Less than 100% of those in a pay grade within zone A or B will receive the bonus, because some may not be at an estimated time of separation (ETS) point, and some may chose to extend rather than reenlist. Therefore, the bonus amount is calculated conditional upon receiving it. Then the bonus amount is multiplied by the probability of receiving it.

AVERAGE COST: The average cost of reenlistment bonuses will vary by MOS because the award level (A_{kz}) and basic pay (bp_{jkz}) at each zone vary by MOS. The average cost of a reenlistment bonus for MOS k at zone z in pay grade j for a member who reenlists for Y_{kz} years is given by:

$$(3.17) \qquad SRB_{jkz} = 0.5A_{kz}(Y_{kz})(bp_{jkz}) + 0.5A_{kz}\frac{\sum_{n=1}^{L_{kz}} bp_{jkz}}{(1+r)^{n}}$$

This calculates the average cost of the bonus for those in pay grade j and MOS k at zone z, assuming that they get the bonus. Then the unconditional average cost is

$$(3.18) \qquad AC_{jk}^{SRB_z} = \left(\frac{\dfrac{\sum_{i\ zoneA} E_{ijk} \cdot ETS_i r_{ik}}{30}}{\sum_{i=1} E_{ijk}}\right)SRB_{jkz}$$

where ETS_i is the proportion at an ETS point in year of service i and r_{ik} is the reenlistment rate at year of service i in MOS k. This computation is made for all relevant zones and pay grades.

MARGINAL COST: The marginal cost computation of the reenlistment bonus includes the cost of the infra-marginal rents that would be paid to those who would reenlist anyway. The equation for the marginal cost of an SRB in grade j and MOS k at Zone z is given by

$$(3.19) \qquad MC_{jk}^{SRB} = (\overline{P_{kz}} + SRB_{jkz})\left(1 + \frac{1}{S_z^e}\right) - \overline{P_{kz}}$$

P is the relevant measure of non-bonus pay for which the elasticity is computed.[3] It is subtracted because we are including only the SRB costs of the marginal reenlistees.

DISCUSSION:

- The methods used here discounted the present value of the bonus payments to the reenlistment decision point at the government's discount rate. It computes discounted obligations. One could assume that the government's discount rate is zero and compute undiscounted obligations. Alternatively, one could compute actual outlays, rather than obligations, since the outlays occur over the reenlistment contract.

- The SRB itself is a function of basic pay at the time of reenlistment. If basic pay increases, bonus costs also will increase. This function is an advantage of explicit modeling of bonus costs.

- The SRB award levels can be changed for each MOS, zone, and year, at the option of the user. The default option for all years is the bonus policy in effect for FY 1990, or the most recent database update.

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[3]To understand this formulation, note that:

Total Cost = PQ = Price * Quantity

$$\frac{dTC}{dQ} = Q\frac{dP}{dQ} + P$$

$$\text{Marginal Cost} = P\left(\frac{Q}{P} + 1\right) = P\left(\frac{1}{S^*} + 1\right)$$

S^* is the supply elasticity, $P = \overline{F}_b + AC^{RB}$

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NOTATION:

SRB_{jkz} = Average cost of a reenlistment bonus for pay grade j and MOS k at zone z for a member who reenlists for Y_{kz} years

A_{kz} = Award level for MOS k at zone z

AC_{jk}^{SRB} = Unconditional average cost of an SRB bonus for grade j and MOS k

MC_{jk}^{SRB} = Marginal cost of an SRB bonus for grade j and MOS k

E_{ijk} = Inventory of enlisted soldiers in YOS i, grade j, and MOS k

ETS_i = Proportion of members at estimated time of separation (ETS) at YOS i

r_{ik} = Reenlistment rate at YOS i in MOS k

S_z^e = Supply elasticity at zone z

bp_{jkz} = Basic pay in grade j and MOS k at zone z

$\bar{P}_{kz}$ = Average non-bonus pay for MOS k at zone z

Y_{kz} = Average reenlistment contract length, in years, for MOS k and zone z

STRUCTURED COST DATABASE VARIABLES - *Definitions*

ac_srb	-	Average SRB cost weighted by probability of receiving bonus
srb	-	Value of SRB, conditional upon receipt
mc_srb	-	Marginal cost of paying an SRB to a soldier

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
r	discount rate	srbparms.enl	OMB Circ A-76
length1	avg term of reup, zone A	srbparms.enl	Assumed = 4
length2	avg term of reup, zone B	srbparms.enl	Assumed = 4
ave_pay_a	meas of pay for supply elast, zone A	srbparms.enl	Update Prgm
ave_pay_b	meas of pay for supply elast, zone B	srbparms.enl	Update Prgm
Se_a	supply elasticity, zone A	srbparms.enl	Assumed = 2
Se_b	supply elasticity, zone B	srbparms.enl	Assumed = 1
award1	SRB award level 1	srb_data.enl	DAPE-MPE
award2	SRB award level 2	srb_data.enl	DAPE-MPE
baspay	basic pay	mcparms.enl	MPA J-BOOK
inv	inventory by grade & yos	inv.enl	DMDC

3.4 SPECIAL PAYS

COMPOSITION: Includes hazardous duty, sea/foreign duty, medical personnel, diving duty, overseas allowances, language proficiency pay, family separation allowance, and special duty assignment pay. Special duty assignment pay is authorized only for a selected population of enlisted members assigned to demanding and/or duties with higher degree of responsibilities such as special forces or recruiting assignments and overseas extensions.

AVERAGE COST/MARGINAL COST: The average cost of special pays in the sea/foreign duty category varies by grade. The cost is calculated using an historical probability for foreign duty pay multiplied by current probability of foreign duty by grade multiplied by the foreign duty pay rate.

The average cost of special pays in the overseas allowance category varies by grade. The average cost for pays in pay grade j is computed by multiplying percent of Army personnel overseas times percent OCONUS by MOS times overseas rates by grade.

The average cost of special pays in the language proficiency and diving duty category will be assigned only to certain MOSs. Certain MOSs will receive the predetermined amount and all other MOSs will receive zero for special pays in this category.

The average cost of special pays in the medical pays category is calculated by MOS and grade. MOSs in the medical, dental, or veterinary fields are given a weighted average by grade of total medical pays.

Family separation pay is paid to members with dependents on duty outside the United States or in Alaska when travel of dependents is not authorized and the member maintains two homes. The average cost is calculated by multiplying the family separation rate for each grade as shown in the budget by the probability of family separation.

$$(3.20) \qquad AC_j^{FSA} = FSA_j \cdot P^{fs}$$

Average cost of special duty pay is calculated by dividing the total amount of special duty pay by the number of recipients. This "rate" is applied directly to those MOSs (CMF 79) that receive special duty pay.

Average cost of hazardous duty is the total amount of hazardous duty pay, less that paid to specific MOSs, divided by the total Army. The exception to this is that specific MOSs always receive certain hazardous duty pays and, in such cases, are given the set amount rather than the average. A member can receive at most two hazardous duty pays per year.

NOTATION:

AC_j^{FSA} = Average cost of family separation pay for grade j

FSA_j = Family separation pay rate for grade j

P^{fs} = Probability of family separation

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_dive	-	Average cost of diving duty pay
ac_lang	-	Average cost of language proficiency pay
ac_acip	-	Average cost of aviation career incentive pay
ac_sd	-	Average cost of special duty assignment pay
ac_fd	-	Average cost of foreign duty pay
ac_os	-	Average cost of overseas duty pay
ac_haz	-	Average cost of hazardous duty pay
ac_med	-	Average cost of medical professional pay
ac_fsa	-	Average cost of family separation allowance
ac_sp	-	Average cost of special pay

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
freq	foreign pay frequency	foreign.enl	JUMPS FY85
oconus	percent of MOS oconus	oconus.enl	PERSCOM
os_perc	percentage overseas	spparms.enl	MPA J-BOOK
haz-pay	hazardous duty pay	spparms.enl	MPA J-BOOK
totdiv	total diving duty pay	spparms.enl	MPA J-BOOK
totlang	total language proficiency pay	spparms.enl	MPA J-BOOK
totsd	special duty assignment pay	spparms.enl	MPA J-BOOK
langinv	total inv for 97E, 98G, 18F	spparms.enl	DMDC
fsa	family separation allowance	spparms.enl	MPA J-BOOK
fd	# receiving foreign duty pay	spparms.enl	MPA J-BOOK
ginv	grade inventory by MOS	enlisted.dat	
sp_names	special pay names	spparms.enl	MPA J-BOOK
sp_rates	special pay rates	spparms.enl	MPA J-BOOK

3.5 TRAINING

COMPOSITION: Includes all variable costs of individual training, including initial training (recruit training, initial skill training, and one station unit training), other specialized skill training of individuals, and NCO professional training.

- *Recruit Training.* Provides for basic training to individual recruits. An eight-week introductory and combat survival skill training course given to enlisted personnel upon their initial entry into military service. It includes training to prior service personnel in need of refresher training. Enlisted training only.

- *Initial Skill Training.* Includes all formal training normally given immediately following recruit training and leads to the award of a military occupational specialty (MOS) at the lowest level. Enlisted training only.

- *One Station Unit Training (OSUT).* Combines recruit training and initial skill training for enlisted personnel in the combat arms and certain combat skills into a single course. Training is conducted at a single station under a single cadre. Enlisted training only.

- *Skill Progression Training.* Provides specialized skill training to enlisted members subsequent to initial skill training. Through skill progression training, students gain the knowledge to perform at higher skill levels or in superior positions. Enlisted training and officer training.

- *Flight Training.* Includes courses in the Army's flight training programs, categorized as either Undergraduate or Graduate Pilot Training. Undergraduate Pilot Training (UPT) qualifies both commissioned and warrant officer aviation students to perform duties and assume the responsibilities of Army pilots. Graduate Pilot Training includes courses for instructor pilots, instrument flight examiner, gunnery, and specific pilot qualifications courses in various aircraft. Officer training only.

- *Academies and Senior ROTC.* Provides initial training for officer accessions (see Officer Acquisition Module).

- *Professional Training.* Provides education to selected military and civilian personnel DoD-wide to prepare them to perform increasingly complex tasks that become their responsibilities as they progress in their careers (e.g. NDU, AWC, C&GSC, DSMC, USASMA, and NCOES training).

AVERAGE COST: The traditional source of this data is the Resource Management Office of USA TRADOC. They produce the ATRM-159 report which displays course costs for TRADOC schools. A similar report is provided by the Army Health Services Command for medical courses. The reports display calculated course costs based on instructor contact hours, student load, costs of supplies, ammunition, the flying hour program and costs based on medical support, base support, and family housing.

MPA Costs. The ATRM-159 determines MPA costs by calculating the pay and the allowances of both the students and the instructors for each course. The ATRM-159 determines instructor contact hours converted to man-years and multiplies it by the average military compensation for each grade. Student pay and allowances is determined by first averaging student input and output

and multiplying by the course length to get student manyears. Then manyears are multiplied by the average military compensation for the modal grade to get student pay and allowances. A pro rata share of the pay and allowances for the military working in Base Support and Medical Support also are added to the MPA cost factor.

OMA Costs. The ATRM-159 reports costs that reflect the actual O&M costs spent for individual training courses. It includes instructors' materials, flying hour costs (where applicable), and overhead costs. Again, a pro rata share of the O&M piece of Base Support and Medical Support are included in the cost factor. The OMA costs include pay for civilians. Costs are allocated per training man-week.

Other Costs. These costs include support costs (e.g., procurement of training devices and training ammunition) other than MPA and OMA. The ATRM-159 computes equipment depreciation costs by amortizing procurement costs over a 10 year period. Ammunition costs are computed by dividing the total cost of ammunition per course by trainee per course. This equals ammunition cost per trainee.

In each of the above appropriations, AMCOS will read the direct, variable costs per MOS directly into the structured cost database.

Average cost of training is the variable cost per MOS course as calculated by ATRM-159. However, AMCOS calculates a weighted average variable cost for all enlisted using the average costs per MOS and the baseline inventories as weights. The costs displayed in the structured database are as follows:

- average cost of basic training

- average cost of initial skill (or AIT) training

- average cost of one station unit training

- average cost of career training (reflected in grades five through nine)

- average cost of all training by grade

MARGINAL COST: Marginal cost is equal to average cost of training. For those MOSs that have a choice between OSUT and basic and AIT, the marginal cost will be equal to the cost of basic and AIT.

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_btr	-	Average cost of basic training
ac_osut	-	Average cost of one station unit training
ac_istr	-	Average cost of initial skill training (AIT)
ac_cartr	-	Average cost of career training
ac_tng	-	Average cost of all training combined for a given grade
mc_tng	-	Marginal cost of all training combined for a given grade
ac_proftr	-	Average cost of professional training
ac_upt	-	Average cost of undergraduate pilot training
ac_ofltr	-	Average cost of other flight training

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
perc	fraction of MOS given OSUT	tr_osut.enl	TRADOC
osut_mpa	MPA cost of OSUT	tr_osut.enl	TRADOC
osut_oma	OMA cost of OSUT	tr_osut.enl	TRADOC
osut_other	OTHER cost of OSUT	tr_osut.enl	TRADOC
cr_sl	skill level of course	tr_cartr.enl	TRADOC
cr_num	course number or name	tr_cartr.enl	TRADOC
cr_mpa	MPA cost of course	tr_cartr.enl	TRADOC
cr_oma	OMA cost of course	tr_cartr.enl	TRADOC
cr_other	OTHER cost of course	tr_cartr.enl	TRADOC

3.7 MEDICAL SUPPORT

COMPOSITION: Consists of all fixed and variable non-pay costs that provide health care to the member and his or her family. It includes the Civilian Health and Medical Program for the Uniformed Services (CHAMPUS) and the care provided by the military hospital system.

AVERAGE COST/MARGINAL COST: Health care support costs are broken into two pieces, the cost of CHAMPUS and the cost of care in the military hospitals.

- CHAMPUS costs vary as a function of family size and age of dependents. Family size tends to vary directly with grade. Average cost, then, is estimated by using the total government cost for CHAMPUS (inpatient and outpatient care) multiplied by the average family size per grade to give us average CHAMPUS cost by grade.

(3.21)
$$AC_j^{CHAMPUS} = AC^{CHAMPUS,dep} (AFS_j - 1)$$

- Military health care support costs are a function of the size and number of military hospitals and the medical force structure. Military medical force structure is sized to provide for an orderly transition to wartime status in the event of mobilization. The medical facilities are for providing training to medical personnel filling the force structure. Secondary is the care provided to members and their families. The medical force structure is independent of the size of the current Active Army End Strength and current personnel compensation issues. To count this as a manpower cost of the current force is questionable, therefore, calculation of average costs will not include cost of facilities or the military pay of doctors and other military medical personnel. The Army would incur these costs regardless. To calculate the cost of direct care in the military health care system the following equation is used:

(3.22)
$$AC_j^{Med} = AC^{MED,member} + AC^{MED,dep} (AFS_j - 1)$$

$AC^{MED,member}$ and $AC^{MED,dep}$ represent the average cost of medical and dental care for military members and their dependents, respectively; AC_j^{MED} is the average cost of military hospital care; and AFS_j represents the average family size by grade. The values for these variables are based on information obtained from the Medical Expense and Performance Reporting System (MEPRS).

NOTATION:

$AC_j^{CHAMPUS}$ = Average CHAMPUS cost per member in grade j

$AC^{CHAMPUS,dep}$ = Average CHAMPUS cost per dependent

AFS_j = Average family size of a member in grade j

AC_j^{MED} = Average cost of medical and dental care per member in grade j

$AC^{MED,member}$ = Average cost of medical and dental care for military members

$AC^{MED,dep}$ = Average cost of medical and dental care for dependents of military members

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_mdsp   -   Average medical support costs per member by grade

ac_champ   -   Average cost of CHAMPUS per member per grade

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
cc_tot	total CHAMPUS costs	mdbparms.enl	OMA J-BOOK
oma_m	total p8m medical costs	mdbparms.enl	OMA J-BOOK
oma_d	total p8m dental costs	mdbparms.enl	OMA J-BOOK
afs	average family size	mdbparms.enl	AFCSC

3.8 OTHER BENEFITS

COMPOSITION: Consists of all fixed and variable costs that provide miscellaneous benefits. It includes death gratuities paid to beneficiaries of military personnel who die during active duty, apprehension of deserters, unemployment compensation paid to eligible ex-servicemen, survivor benefits paid to spouses and children of deceased service members, separation pay, family separation allowance, clothing allowances, benefits provided under the MWR program, and government contribution to social security tax.

AVERAGE COST/MARGINAL COST:

Miscellaneous. Average cost of death gratuities, apprehension of deserters, and unemployment compensation are determined by dividing their total cost by the total member inventory. This average then can be applied to all members.

$$(3.23) \qquad AC^{misc} = \frac{OB_{tot}}{\sum\limits_{j=1}^{9} E_j}$$

Here, OB_{tot} equals total MPA costs for death gratuities, apprehension of deserters, and unemployment compensation.

Clothing Allowance. Each member is authorized an initial issue plus a cash payment of a basic maintenance allowance through her or his 36th month and a cash payment of a standard maintenance allowance from the 37th month through the end of her or his enlistment. Rates are found in the Army's budget justification books for MPA. The model uses three clothing rates, each a weighted average across sex.

FICA. The FICA tax represents the funds paid (employer's tax) to the Social Security Administration as required by the Federal Insurance Contribution Act. The FICA tax is developed by multiplying the members annual base pay (up to $54,600 for FY91) by the applicable percentage. The model will apply the current FICA tax rate to the average cost of basic pay.

$$(3.24) \qquad AC_{jk}^{FICA} = \%FICA \cdot AC_{jk}^{bp}$$

Survivors' Benefits. Survivors' benefits represent the cost of providing payments of Social Security benefits to widows and orphans of active military members. The costs are averaged over all service members.

$$(3.25) \qquad AC^{SB} = \frac{SB_{tot}}{\sum\limits_{j=1}^{9} E_j}$$

Morale, Welfare, and Recreation Benefits. These benefits are paid for with OMA dollars. A review of service member use of MWR activities indicates that there is little or no variation across grade or MOS, therefore average cost of MWR is applied equally to each member by AMCOS. To calculate

the average cost of MWR activities, OMA costs are totaled and then divided by the total Army inventory to determine a per capita cost for each member.

$$(3.26) \qquad AC^{MWR} = \frac{OMA_{tot}^{MWR}}{\sum\limits_{j=1}^{9} E_j}$$

NOTATION:

AC^{misc}	=	Average cost of miscellaneous pay paid to members
E_j	=	Inventory of enlisted soldiers in grade j
%FICA	=	Current FICA tax rate
AC_{jk}^{bp}	=	Average annual basic pay paid to members in grade j and MOS k
SB_{tot}	=	Total cost of survivor benefits
OMA_{tot}^{MWR}	=	Total OMA costs of morale, welfare, and recreation benefits
OB_{tot}	=	Total cost of other benefits
AC_{jk}^{FICA}	=	Average cost of FICA tax for grade j and MOS k
AC^{SB}	=	Average cost of survivors' benefits per member
AC^{MWR}	=	Average cost of providing morale, welfare, and recreation activities per member

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_cloth	-	Average cost of clothing allowance
ac_fica	-	Average cost of government contribution to FICA
ac_survben	-	Average cost of survivors' benefits
ac_misc	-	Average cost of miscellaneous benefits (death gratuities, apprehension of deserters, and unemployment compensation)
ac_mwr	-	Average cost of MWR
ac_ob	-	Average cost of other benefits

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
ob	total MPA costs for misc benefits	obparms.enl	MPA J-BOOK
bp	base pay	enlisted.dat	PAY TABLES
aml	average monthly leave	obparms.enl	MPA J-BOOK
aml_freq	frequency of cash for leave	obparms.enl	MPA J-BOOK
sev_pay	total Army severance pay	obparms.enl	MPA J-BOOK
fica	FICA percentage for base year	obparms.enl	SOCIAL SEC ADMIN
ficalimit	maximum pay that is taxed	obparms.enl	MPA J-BOOK
surv_ben	total Army survivor benefits	obparms.enl	MPA J-BOOK
cloth_1	clothing allowance for E1-E2	obparms.enl	MPA J-BOOK
cloth_2	clothing allowance for E3	obparms.enl	MPA J-BOOK
cloth_3	clothing allowance for E4-E9	obparms.enl	MPA J-BOOK
tot_mwr	total oma cost of MWR	obparms.enl	OMA J-BOOK

3.9 PERMANENT CHANGE OF STATION

COMPOSITION: Divided into five categories of moves: rotational, operational, accession, training, and separation moves. This module calculates the costs for each of these categories but reflects only the cost of rotational, operational, and separation moves in the totals for this cost element. Accession moves and training moves reflected in the totals of other cost elements (recruiting and training respectively).

AVERAGE COST/MARGINAL COST: PCS costs are a function of the weight allowance per grade, tour length, and inventory of the MOS requirements overseas. Before costs can be calculated, however, weight allowances must be adjusted to take into account the rules that apply to E-4s and below. Two rules apply: 1) whether or not the member has dependents and 2) whether or not the member has less than two years of service. To calculate a single weight allowance each for E-4s and E-1/E-3s, we applied the current distribution of married/unmarried members with less than two years of service and calculated a weighted average.

$$(3.27) \qquad WA_{1/3,t} = \frac{(5000 \cdot E_{1/3,t} \cdot x_{1/3}) + (2000 \cdot E_{3,t} + 1500 \cdot E_{1/2,t})(1-x_{1/3})}{E_{1/3,t}}$$

$$(3.28) \qquad WA_{4,t} = 8000 x_4 y_{4,t} + 7000(x_4 + y_{4,t} + 2x_4 y_{4,t}) + 3500(1-x_4)(1-y_{4,t})$$

Then we calculated the weighted average weight allowance for each grade.

$$(3.29) \qquad WA_5 = 7000(1-x_5) + 9000 x_5$$

$$(3.30) \qquad WA_6 = 8000(1-x_6) + 11000 x_6$$

$$(3.31) \qquad WA_7 = 10500(1-x_7) + 12500 x_7$$

$$(3.32) \qquad WA_8 = 11000(1-x_8) + 13500 x_8$$

$$(3.33) \qquad WA_9 = 12000(1-x_9) + 14500 x_9$$

Accession. The cost factor for accession moves is the average cost per accession move.[4] We apply this factor against the number of accessions in a projection year.

Separation. The cost factors for separation moves equal the estimated average costs per separation move by grade. We use weight allowances by grade to expand the all-Army average cost of a separation move into a per-grade cost,
where AC^{SEPM} is the Army average cost of a separation move, WA_j is the average weight allowance in grade j, and E_j and E are the grade j and total baseline strengths, respectively.

---

[4]Per-move average costs, by type of move, are available from ODCSPER.

$$(3.34) \qquad AC_j^{SEPM} = \frac{AC^{SEPM} \, WA_j}{\sum_j WA_j \frac{E_j}{E}}$$

Training. The training move cost factors are defined as the average cost of a training move by grade. They are calculated in an analogous fashion to the separation move factors, so that

$$(3.35) \qquad AC_j^{TRNM} = \frac{AC^{TRNM} \, WA_j}{\sum_j WA_j \frac{E_j}{E}}$$

where AC^{TRNM} is the Army average cost for a training move.

Rotational and Operational. AMCOS calculates and displays the cost per OCONUS and CONUS moves just as it does for the other categories of moves. However, for CONUS and OCONUS moves AMCOS also calculates the probability of a move prior to calculating the average cost of any PCS moves per member in a particular grade.

The average cost of an OCONUS move, given that a move is made, is

$$(3.36) \qquad AC_j^{ROTS} = AC^{ROTS} \frac{WA_j}{\sum_j WA_j \frac{E_j}{E}}$$

The average cost of a CONUS move, given that a move is made, is

$$(3.37) \qquad AC_j^{OPS} = AC^{OPS} \frac{WA_j}{\sum_j WA_j \frac{E_j}{E}}$$

In calculating the average cost of CONUS and OCONUS moves per member, the probability of making a move is taken into account. The key assumption in calculating this probability is that operational moves are generated as a residual, after moves out of OCONUS fill the empty CONUS positions and separations and accessions are accounted for. This means that the average cost of a rotational move can be expressed as

$$AC_{jk}^{ROTS} = \rho^{oc} AC_j^{ROTS}$$

$$(3.38)$$

$$where \ \rho^{oc} = \left(\frac{2OC_k}{TL_k^{oc}}\right) - \left[OC_k(1 - c_{jk})\right] - OC_k(Acc)$$

where the term ρ^{oc} is the probability of a service member making a rotational move, which varies by MOS as denoted by the subscript k. The per capita moves required to move members from overseas and to replace those departing overseas is given by two times the proportion of members stationed

overseas, 2OC, divided by the expected OCONUS tour length, TL^{oc}, less the per capita moves required to rotate members who will be separating from the Army, the second term in brackets, less a percentage that represents accession moves to OCONUS positions, $OC_k(Acc)$, where Acc is the percentage of the total force that are accessions. The per capita moves value for those members whose OCONUS tour has ended is achieved by multiplying the proportion of members stationed oversees by the average continuation rate, c_{jk}, to avoid double counting moves associated with separations.

The average cost of an operational move per member is then calculated as

$$AC_{jk}^{OPS} = \rho^c AC_j^{OPS}$$

(3.39)

$$\text{where } \rho^c = \left(\frac{1 - OC_k}{TL_k^c}\right) - \left[\frac{OC_k}{TL_k^{oc}} - OC_k(1 - c_{jk})\right] - (1 - OC_k)(Acc)$$

The term ρ^c is the probability of making an operational move, which equals the per capita moves required to fill CONUS positions (the proportion of CONUS members divided by the average CONUS tour length, TL^c), less the number of positions that will be filled by members rotating back from OCONUS, the second term in brackets, and less the proportion of those accession moves made to CONUS positions .

The structured cost database, then, displays an average cost of a PCS move that is calculated as shown below.

(3.40)
$$AC_{jk}^{PCS} = AC_{jk}^{ROTS} + AC_{jk}^{OPS}$$

DISCUSSION: Missing from the equations is an equation describing the equilibrium tour length. Our simplifying assumption is that there are sufficient CONUS billets such that the number of operational moves adjust to whatever tour lengths for CONUS and OCONUS are specified.

NOTATION:

WA_{jk} = Composite weight allowance for grade j and MOS k

AC_{jk}^{PCS} = Average cost of a permanent change of station for grade j and MOS k

AC_{jk}^{SEPM} = Average cost of a separation move for grade j and MOS k

AC_{jk}^{TRNM} = Average cost of a training move for grade j and MOS k

AC_{jk}^{ROTS} = Average cost of a rotational move for grade j and MOS k

AC_{jk}^{OPS} = Average cost of an operational move for grade j and MOS k

OC_k = Percentage of members OCONUS in MOS k

TL_k = Tour length (either OCONUS or CONUS) for members in MOS k

E_{jk} = Member inventory in grade j and MOS k

E	=	Total member inventory
c_k	=	Average continuation rate
Acc	=	Percentage of total force that are accessions
ρ^r	=	Expected number of rotational moves per member (varies by MOS as denoted by the subscript k)
ρ^c	=	Probability of an operational move
x_j	=	% members with dependents in grade j
y_j	=	% members in grade j with GTE 2 YOS

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_amov	-	Average cost of an accession move
ac_ops	-	Average cost of an operational move
ac_rots	-	Average cost of a rotational move
ac_smov	-	Average cost of a separation move
ac_tmov	-	Average cost of a training move
ac_pcs	-	Average cost of pcs moves

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
ops	composite cost of an operational move	pcsparms.enl	DAPE-MB
rots	composite cost of a rotational move	pcsparms.enl	DAPE-MB
sep	composite cost of a separation move	pcsparms.enl	DAPE-MB
acc	composite cost of an accession move	pcsparms.enl	DAPE-MB
tng	composite cost of a training move	pcsparms.enl	DAPE-MB
depend	% members w/dependents	pcsparms.enl	MPA J-BOOK
percent	% E4s with less than 2 YOS	pcs_data.enl	Calculated
loss	% members separating by grade	pcs_data.enl	Calculated
tc	tour length in CONUS	pcs_tc.enl	DAPC-249
toc	tour length in OCONUS	pcs_data.enl	Assumed = 3
weight	weight allowance by grade	pcsparms.enl	JOINT TVL REG
oconus	percentage of members oconus	oconus.enl	PERSCOM

3.10 OFFICER ACQUISITION

COMPOSITION: Includes costs associated with the acquisition of officers into the Army such as advertising; scholarships (HPSP and ROTC); initial training; military pay and allowances for cadets and officer candidates; and operations and support costs for the U.S. Military Academy, Branch Immaterial Officers' Candidate School, and Reserve Officers' Training Corps.

- United States Military Academy. The curriculum is oriented primarily toward academics during the school year and intensive military training during the summer months. Each July approximately 1,450 new cadets are trained and equipped to enter the Corps of Cadets, bringing it up to its authorized strength of 4,500 cadets. The four-year course of instruction, which results in a Bachelor of Science degree, is designed to produce career-oriented officers for the Army.

- The Branch Immaterial Officer Candidate Course. This course trains selected enlisted persons to serve as commissioned officers in the units of the active and reserve components. With an average load of approximately 210 students, this 14-week course commissions officers in all the accession specialties.

- Senior ROTC. The objective of ROTC is to attract, motivate, and prepare selected college students with potential to serve as commissioned officers in the active and reserve components. The program consists of either a two-year basic course or a six-week basic camp, followed by a two-year advanced course at ROTC locations throughout the United States and its territories. Between their junior and senior years, ROTC cadets typically attend an advanced camp where they receive military training under field conditions. After successful completion of this program, the cadets are commissioned as second lieutenants.

- Health Professionals Scholarship Program. The Army presently is authorized 1,850 students in the HPSP. Students are enrolled in the disciplines of Medical Care, Psychology, and Optometry as authorized by Public Law 92-246. Costs reflect payment for tuition and other education expenses (school supplies, microscope rental, text books, etc.) incurred by the participants.

AVERAGE COST: Officer acquisition costs are computed for both MPA and OMA appropriations. MPA costs are determined by combining student pay and allowances with instructor pay and allowances and dividing by the number of graduates and then adding the average cost of a training move. OMA costs are determined in a similar manner, combining advertising costs, scholarship costs, and operational support costs. These costs then are divided by the number of graduates.

(3.41)
$$AC_{ja}^{Offce}(MPA) = \frac{MY_n^{Stud} \cdot AC_j^{mc} + MY_n^{Inst} \cdot AC_j^{mc}}{O_{ja}^{Grad}} + AC_j^{TMGM} \quad \text{and}$$

$$AC_{ja}^{Offce}(OMA) = \frac{OS_n^{Trg} + Adv_n + Schl_n}{O_{ja}^{Grad}}$$

MARGINAL COST: Marginal cost is the average cost of acquiring the OCS student. During periods of expansion, the Army traditionally uses OCS to meet the increased officer demands.

Besides the fact that West Point enrollment is fixed by law, OCS is also the cheapest of the four methods of acquiring officers.

NOTATION:

AC_{jn}^{OffAcc} = Average cost of officer acquisition into grade j from source of commission n

MY_{jn}^{Stud} = Student manyears in grade j from source of commission n

MY_{jn}^{Inst} = Instructor manyears in grade j from source of commission n

O_{jn}^{Grad} = Officer graduates into grade j from source of commission n

OS_{n}^{Trs} = Operations and support costs for source of commission n

Adv_{n} = Cost of advertising for source of commission n

$Schl_{n}$ = Cost of scholarships for source of commission n

AC_{j}^{TNGM} = Average cost of a training move for grade j

AC_{j}^{ac} = Average annual compensation for grade j

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_ocs   -   Average cost of training an OCS candidate
ac_wp   -   Average cost of training a West Point cadet
ac_rotc   -   Average cost of training an ROTC cadet
ac_hp   -   Average cost of an HPSP scholarship
ac_off   -   Average cost of accessing an officer
mc_off   -   Marginal cost of accessing an officer

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
stmy_1	USMA student manyears	acqparms.off	OMA J-BOOK
stmy_2	OCS student manyears	acqparms.off	"
stmy_3	ROTC student manyears	acqparms.off	Assumed = 0
stmy_4	HPSP student manyears	acqparms.off	OMA J-BOOK
grad_1	USMA graduates	acqparms.off	"
grad_2	OCS graduates	acqparms.off	"
grad_3	ROTC graduates	acqparms.off	"
grad_4	HPSP graduates	acqparms.off	OTSG
os_tng_1	USMA operational support costs	acqparms.off	OMA J-BOOK
os_tng_2	OCS operational support costs	acqparms.off	OMA J-BOOK
os_tng_3	ROTC operational support costs	acqparms.off	OMA J-BOOK
os_tng_4	HPSP operational support costs	acqparms.off	Assumed = 0
adv_1	USMA advertising costs	acqparms.off	DAPE-ZXA
adv_2	OCS advertising costs	acqparms.off	Assumed = 0
adv_3	ROTC advertising costs	acqparms.off	DAPE-ZXA
adv_4	HPSP advertising costs	acqparms.off	"
imy_off_1	USMA OFFICER instructor costs	acqparms.off	OMA J-BOOK
imy_off_2	OCS OFFICER instructor costs	acqparms.off	OMA J-BOOK
imy_off_3	ROTC OFFICER instructor costs	acqparms.off	"
imy_off_4	HPSP OFFICER instructor costs	acqparms.off	"
imy_enl_1	USMA ENLISTED instructor costs	acqparms.off	Assumed = 0
imy_enl_2	OCS ENLISTED instructor costs	acqparms.off	"
imy_enl_3	ROTC ENLISTED instructor costs	acqparms.off	"
imy_enl_4	HPSP ENLISTED instructor costs	acqparms.off	"
pay_03	average annual pay for 03	acqparms.off	AMCOS
SCDBpay_04	average annual pay for 04	acqparms.off	AMCOS SCDB
pay_E6	average annual pay for E6	acqparms.off	AMCOS SCDB
pay_E7	average annual pay for E7	acqparms.off	AMCOS SCDB
sch_1	USMA scholarship costs	acqparms.off	Assumed = 0
sch_2	OCS scholarship costs	acqparms.off	Assumed = 0
sch_3	ROTC scholarship costs	acqparms.off	OMA J-BOOK
sch_4	HPSP scholarship costs	acqparms.off	OMA J-BOOK

3.11 NEW GI BILL

COMPOSITION: Estimates the expected present value of the basic benefit associated with the New GI Bill. The basic benefit is actually funded by the Veteran's Administration and does not appear in either the Army's nor the Department of Defense's budget. However, this module computes the expected present value, at the time of enlistment, of the net government outlays associated with the basic benefit. (The estimated cost of "kickers" are included in the recruiting cost module.)

To participate in the basic benefit of the New GI Bill, a member must be a high school graduate and must decide to participate in the benefit shortly after her enlistment. The program is contributory, and if a member chooses to participate, $100 per month for twelve consecutive months is deducted from the participant's pay check.

The basic benefit is equal to $300 per month for up to 36 months for an enlistment of three or more years, and $250 per month for 36 months for an enlistment of two years. The stipend is payable to individuals who enroll in full-time college programs. Partial payments are awarded to members who enroll in part-time programs.

Expected Present Value Computations:

Let EPVi(4) be the expected present value of the Army College Fund for four-year enlistments in year of service i. Then,

(3.42)

$$
EPV_{k,4} = P_{k,4}\left(\sum_{t=1}^{12}\frac{-100}{\left(1+\frac{r}{12}\right)^t} + U_{k,4,1}\sum_{t=49}^{57}\frac{300}{\left(1+\frac{r}{12}\right)^t} + U_{k,4,2}\sum_{t=61}^{69}\frac{300}{\left(1+\frac{r}{12}\right)^t}\right)
$$

$$
+ P_{k,4}\left(U_{k,4,3}\sum_{t=73}^{81}\frac{300}{\left(1+\frac{r}{12}\right)^t} + U_{k,4,4}\sum_{t=85}^{93}\frac{300}{\left(1+\frac{r}{12}\right)^t}\right)
$$

In this equation $P_{k,4}$ is the participation rate in the program among four-year enlistees in MOS k; $U_{k,4,t}$ is the usage rate for four-year recruits in MOS k, t years after completing their initial contract; and r is the discount rate. Note that the maximum for $U_{k,4,t}$ is 1 minus the first term reenlistment rate for four-years enlistment in MOS k. Then, $EPV_{k,3}$ is the expected present value of the government outlays for three-year enlistments in MOS k.

$$EPV_{k,3} = P_{k,3}\left(\sum_{t=1}^{12}\frac{-100}{\left(1+\frac{r}{12}\right)^t} + U_{k,3,1}\sum_{t=37}^{45}\frac{300}{\left(1+\frac{r}{12}\right)^t} + U_{k,3,2}\sum_{t=49}^{57}\frac{300}{\left(1+\frac{r}{12}\right)^t}\right)$$

(3.43)

$$+ P_{k,3}\left(U_{k,3,3}\sum_{t=61}^{69}\frac{300}{\left(1+\frac{r}{12}\right)^t} + U_{k,3,4}\sum_{t=73}^{81}\frac{300}{\left(1+\frac{r}{12}\right)^t}\right)$$

Finally, the expected present value for a two-year enlistment in MOS k is

$$EPV_{k,2} = P_{k,2}\left(\sum_{t=1}^{12}\frac{-100}{\left(1+\frac{r}{12}\right)^t} + U_{k,2,1}\sum_{t=25}^{33}\frac{250}{\left(1+\frac{r}{12}\right)^t} + U_{k,2,2}\sum_{t=37}^{45}\frac{250}{\left(1+\frac{r}{12}\right)^t}\right)$$

(3.44)

$$+ P_{k,2}\left(U_{k,2,3}\sum_{t=49}^{57}\frac{250}{\left(1+\frac{r}{12}\right)^t} + U_{k,2,4}\sum_{t=61}^{69}\frac{250}{\left(1+\frac{r}{12}\right)^t}\right)$$

Then, the expected present value of the government outlays for the basic benefit is

(3.45)
$$EPV_k = a_1 EPV_{k,2} + a_2 EPV_{k,3} + a_3 EPV_{k,4}$$

where a_1, a_2, and a_3 are, respectively, the proportions of two-, three-, and four-year enlistments in MOS k.

SIMPLIFICATION: Because so many of the basic parameters of this cost equation are unknown, the actual module we will program for in the initial version of the model will be much simpler.

First, calculate

(3.46)
$$PV = \sum_{t=1}^{12}\frac{-100}{\left(1+\frac{r}{12}\right)^t} + \sum_{t=37}^{84}\frac{300}{\left(1+\frac{r}{12}\right)^t}$$

Then, let f be the compounded participation and usage rate among all participants who are not eligible for "kickers," and let cp be the compounded participation and usage rate for those eligible for "kickers." Then, the expected present value for MOS k is

Here, $s_{k,1}$ is the proportion of recruits in MOS k not eligible for educational benefit "kickers"

$$(3.47) \quad EPV_k = s_{k,1}(f)(PV) + s_{k,2}(cp)(PV)$$

$$= PV(s_{k,1}f + s_{k,2}cp)$$

under the New GI Bill, and $s_{k,2}$ is the proportion eligible for "kickers."

DISCUSSION: Because the New GI Bill is in fact new, there is little information on usage rates. One can make an informed guess concerning what they are likely to be, however, we have avoided going into great detail concerning parameters of which we are ignorant.

It is likely that usage rate for the New GI Bill will be significantly greater for those who are eligible for educational benefit kickers. The simple equations allow one to take this into account. Also note that the New GI Bill is funded through the Veteran's Administration budget. It is likely that it will be suppressed in most applications of the life-cycle model.

NOTATION:

$EPV_{k,l}$	= Expected present value of educational incentives in MOS k for enlistment contract length l
r	= Discount rate
PV	= Present value of educational incentives
$P_{k,l}$	= Participation rate of recruits in the New GI Bill
$U_{k,l,s}$	= Usage rate for individuals in MOS k, with contract length l, in year s after completing their initial term of service and leaving the active Army
$S_{k,1}$	= Proportion of recruits to MOS k who are eligible for kickers
$S_{k,2}$	= Proportion of recruits to MOS k who are not eligible for kickers
f	= Compounded participation and usage rate for those who are not eligible for kickers
cp	= Compounded participation and usage rate for those who are eligible for kickers

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_gib   -   Average cost of providing GI Bill benefits to each member

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
w	percen of high qual recruits	rec_data.enl	FORECAST

3.12 SEPARATION COSTS

COMPOSITION: There are three types of separation benefits that service members may receive, depending upon their qualification. These benefits are (1) accrued leave benefits; (2) involuntary separation benefits; and (3) voluntary separation benefits.

Accrued Leave. Each service member that is separated from the Army is entitled to receive payment for the amount of unused leave she or he has accumulated.

Involuntary Separation. Any member forced out, regardless of when he or she entered the service, who has been on active duty at least six years receives a one-time, lump-sum payment. If a member is not qualified for retention -- e.g., QMP, overweight, past a RCP -- she or he may receive only a partial payment. Those members separated for misconduct are not eligible for separation pays.

Voluntary Separation. The services are offering bonuses to selected members with between 6 and 18 years of service to leave active duty voluntarily. The bonuses may be offered to members who have more than six years active service as of December 5, 1991. Members may choose between an annuity (VSI) or a lump sum (SSB). This program is effective through FY95.

In addition to the benefits noted above, each service member that separates is entitled to a separation move.

AVERAGE COST/MARGINAL COST: To calculate the average cost of providing separation benefits to members, we first calculate the cost of each of the three types of payments. Either the payment is a lump sum or it is an annuity. To calculate the cost of the lump sum payment, regardless of the reason for separation, we use the calculation

$$(3.48) \qquad Pmt_{cijk}^{lump} = i(rate_c^{lump})(loss_{cik})(12BP_{ij})\frac{E_{ijk}}{\sum_j E_{ijk}}$$

where i equals a member's YOS, index c indicates the category of separation (i.e., c = 1 indicates voluntary separation, c = 2 indicates involuntary separation with eligibility for full benefits, and c = 3 indicates involuntary separation with only partial payment authorized), $rate_c$ is the percentage of basic pay used depending on the category of separation ($rate_1^{lump}$ = .15, $rate_2^{lump}$ = .10, $rate_3^{lump}$ = .05, and $rate_1^{ann}$ = .025 for each YOS), $loss_{cik}$ is the number of losses experienced in category c by members in YOS i and MOS k. $12BP_{ij}$ is the annual basic pay for a member in YOS i and grade j. The last term in the equation represents the assumption that losses are distributed across grades in proportion with inventory.

To estimate the net present value of providing an annuity to eligible members voluntarily separating, we use the following calculation:

$$(3.49) \qquad Pmt_{cijk}^{ann} = \sum_{n=1}^{2i} \left[\frac{i(rate_1^{ann})(loss_{cik})(12BP_{ij})\frac{E_{ijk}}{\sum_j E_{ijk}}}{(1+r)^n} \right]$$

where n is the year that the annuity is paid, minus the current year, and r is the annual discount rate

(.10). To estimate the average cost of separation, then, we divide the total cost of providing the separation benefits by the population by grade.

$$(3.50) \qquad AC_{jk}^{Sepbenst} = \frac{\sum_{c} \sum_{i} (p^{lump} Pmt_{cijk}^{lump} + p^{ann} Pmt_{cijk}^{ann})}{\sum_{i} E_{ijk}}$$

where p^{lump} and p^{ann} are the probabilities of a voluntary separatee opting for the lump sum benefit or annuity, respectively, and p^{lump} equals $(1-p^{ann})$.

Other Separation Pay. (Lump sum leave payments plus severance/disability pay plus separation move).

      a. When a service member leaves the service, the member is authorized to cash in any unused leave at the rate of basic pay to which he or she is entitled at the time of separation. The average cost of the lump sum leave payment is calculated by multiplying average number of months leave accrued for each grade by base pay by the probability of separation.

$$(3.51) \qquad AC_{jk}^{leave} = AC_{jk}^{bp} \cdot AML_j \cdot p_s$$

      b. A service member is authorized severance pay for disability retirement. The average cost of disability severance is calculated by dividing the total severance pay by the numbers of separatees by grade.

$$(3.52) \qquad AC_j^{sev} = \frac{Sev_{tot}}{\left[\dfrac{AML_j}{AML_{tot}}\right] E_j}$$

      c. Average cost for other separation pay is the sum of the above costs plus the cost of a separation move.

$$(3.53) \qquad AC_{jk}^{OthSep} = AC_{jk}^{leave} + AC_j^{sev} + AC_{jk}^{SepMove}$$

Thus, total separation costs equal the sum of the average costs for separation incentives and other separation costs.

(3.54)
$$AC_{jk}^{Sep} = AC_{jk}^{SepIncent} + AC_{jk}^{OthSep}$$

NOTATION:

Pmt_{cik}^{lump}	= Lump sum payment cost for separation benefits for separation category c, YOS i, and MOS k
c	= Category of separation (c=1, voluntary separation; c=2, involuntary separation but eligible for full benefits; c=3, involuntary separation with partial payment of benefits)
$rate_c$	= Percentage of basic pay depending on category of separation
$loss_{cik}$	= Percentage of losses experienced in separation category by members in YOS i and MOS k
BP_{ij}	= Basic pay for a member in YOS i and grade j
E_{ijk}	= Soldier inventory for YOS i, grade j, and MOS k
Pmt_{cik}^{ann}	= Annuity payment cost for separation benefits for separation category c, YOS i, and MOS k
p^{lump}	= Probability of a voluntary separatee opting for a lump sum benefit
p^{ann}	= Probability of a voluntary separatee opting for an annuity
AC_{jk}^{Sep}	= Average cost of separation for grade j and MOS k
$AC_{jk}^{SepIncent}$	= Average cost of separation incentives for grade j and MOS k
AC_{jk}^{OthSep}	= Average cost of other separation pay for grade j and MOS k
$AC_{jk}^{SepMove}$	= Average cost of a separation move

STRUCTURED COST DATABASE VARIABLES - Definitions

ac_vsi	-	Average cost of voluntary separation incentive
ac_isi	-	Average cost of involuntary separation incentive
ac_othsep	-	Average cost of accrued leave and separation move
ac_sepcost	-	Average cost of all separation costs

UNDERLYING VARIABLES

VARIABLE	DEFINITION	LOCATION	DATA SOURCE
baspay	basic pay by grade and YOS	mcparms.enl	Uniformed Svcs Almanac
inv	inventory of grade, MOS, and YOS	inv.enl	DMDC
losses	losses receiving vsi or full or partial isi by YOS	sepparms.enl	PERSINCOM
discount_rate	annual discount rate	srbparms.enl	assumed = .10
prob_lump	probability of receiving a lump sum incentive pmt rather than an annuity	sepparms.enl	assumed = .98
prob_ann	probability of receiving an annuity pmt rather than lump sum pmt		calculated
annual_rate	vsi multiplier for annuity pmts	sepparms.enl	DCSPER
aml	avg months of leave by grade	sepparms.enl	MPA J-Book
tot_othsep	total cost of accrued leave & sep move cost by grade		MPA J-Book
lump_pmt	lump sep incentive pmts by grade		calculated
npv_ann_pmt	net present value of annual pmt		calculated
ac_vsi	average cost of vsi by grade		calculated
ac_isi	average cost of isi by grade		calculated

APPENDIX B

DISCUSSION OF THE INVENTORY PROJECTION MODULE
DATA REQUIREMENTS

This appendix will discuss the data requirements for the EPICC inventory module, our source for the data, our method of extracting the data, and our methodology for adjusting the raw data, where appropriate. The discussion will be organized by data element. In general our data came from the Enlisted Master File and the ODCSPER Gains and Loss Tapes using SAS programs to extract the data. The raw data was then modified for the EPICC model by SRA. We initially drafted the SAS program then ODCSPER modified the programs and conducted the data retrieval "in-house" to expedite the process.

STRENGTH CONSTRAINTS:

Baseline Inventory. The model requires a baseline starting inventory that reflects the most recent year end position of actual enlisted strength. The inventory should be dimensioned by grade, YOS, and subinventory. To measure grade we sorted by the data element PAYGRADE. We measured YOS as the difference between the end fiscal year date and the basic pay entry date (BPED) measured in years. We counted the inventory within subinventories by using the following variables; SEX, REDCAT, a combination of AFQT score and AFQT category[1], and level of civilian education (HSDG or NHSDG). Using SEX we sorted the inventory by male and female; using REDCAT we sorted by white and other[2]; using AFQT Score and AFQT we sorted by CAT I-IIIA, CAT IIIB, and CAT IV; finally, using CIVED we sorted by HSDG and NHSDG. We also added one cell as a catch-all for collecting records that do not match the above definitions. There will be a total of 25 sub-inventories (2x2x3x2 + 1).

Requirements/Endstrength. The model requires that the user provide force structure requirements by grade for each projection year. These by grade requirements are used as targets by the model. In effect the model minimizes the difference between projected inventory and force structure requirements. The default force structure requirements used in EPICC were provided by DAPE-MPE.

Accession Distribution. The model requires that the user specify a distribution for allocating NPS accessions across subinventories. The default file reflects the distribution from the most recently completed fiscal year. In that file, NPS

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[1] As renormed for faulty test scores from previous years.

[2] The data element REDCAT was chosen so that hispanics would be grouped with blacks. Our assumption is that hispanic behavior is more closely aligned with blacks than with whites.

Accessions were measured using ODCSPER's Gain/Loss Tapes. We measured the number of NPS accessions from each month's tape and accumulated the totals over the whole year for the previous fiscal year. We also accumulated the accessions for each subinventory. The distribution was obtained by dividing totals for each subinventory by the total number of accessions.

<u>Quarterly Timing of Accessions/Accession Losses.</u> To develop some notion of the flow of accessions over a year, the model uses a quarterly distribution of NPS accessions. This distribution is provided by the user; however, the model will use a uniform distribution in the default file. To determine Accession losses (or NPS accession attrition), we measured the following information about the FY90 accession cohort - for each sub-inventory: total number of NPS accessions in FY90; number of soldiers leaving service with 0-3 months of service (m/s); number of soldiers leaving with 4-6 m/s; number of soldiers leaving with 7-9 m/s; and number of soldiers leaving with 10-12 m/s. These numbers, divided by the quarterly cohort endstrength, provide the module with the quarterly attrition rates.

PROMOTION PARAMETERS:

<u>Minimum Promotion Rates.</u> Although the model will first promote to fill vacancies, it also checks promotions against a minimum promotion rate provided by the user. This is the desired minimum rate to maintain reasonable promotion opportunity. They are calculated by DAPE-MPE. The default file reflects the DAPE-MPE rates.

<u>Promotion Rate Adjustment Factors.</u> Default adjustment factors are set at 1.0, however the user may change these factors. The model applies the product of the adjustment factors and the minimum promotion rates to the grade requirements to determine promotion floors.

<u>Primary/Secondary Zones.</u> The default file sets beginning and end points for early and normal promotions in accordance with AR 600-200. The user may also specify a percentage of the total promotions that determines the number of early promotions. These parameters are specified for the grades being promoted <u>from</u>.

PRIOR SERVICE ACCESSIONS: EPPIC uses prior-service data broken two different ways. From the gain/loss tapes we accumulated accessions from each month to build matrices dimensioned 1) by grade and YOS, and 2) by subinventory and term of service. The user must also add the desired number of prior service accessions for each projection year. The default file will reflect PS numbers as determined by DAPE-MB.

RETENTION RATES: The EPICC model uses retention rates that reflect the flow of inventory from one fiscal year to another. As such, the rates are generated by comparing the ending inventories for two successive fiscal years. The model accepts three different types of retention rates; reenlistment rates, extension rates, and non-

ETS continuation rates.

Reenlistment Rates. Baseline reenlistment rates are measured by counting the numbers of reenlistments recorded in the gain/loss tapes for each month, totaling that number over twelve months, and dividing by the number of soldiers on the end FY89 EMF with less than 12 months to ETS. Another input data file contains adjustment factors dimensioned by projection year, subinventory, and ranges of YOS (1-5, 6-10, 11-31). The default file will contain factors of 1.0.

Extension Rates. Baseline extension Rates are measured in a similar manner by counting the number of recorded extensions on the gain/loss tape and dividing by the number of soldiers in the end FY89 EMF with less than 12 months to ETS. As with reenlistment rates another input data file contains adjustment factors dimensioned by projection year, subinventory, and ranges of YOS (1-5, 6-10, 11-31). The default file will contain factors of 1.0.

Non-ETS Continuation Rates. We defined a continuation as any soldier who was not at ETS, continued on to the next year. The baseline continuation rates are measured by comparing EMF snapshots for end FY89 and FY90. The denominator is the number of records in the FY89 snapshot with a time-to-ETS of greater than 12 months. The numerator is the number of FY89 records remaining in the FY90 snapshot. Here too there is an additional input data file that contains adjustment factors dimensioned by projection year, subinventory, and ranges of YOS (1-5, 6-10, 11-31). The default file will contain factors of 1.0.

Allocation rates for Non-ETS Reenlistments and Extensions. Still using the gain/loss tapes, we extract the numbers of non-ETS reenlistments and extensions. These numbers divided by the non-ETS population provides the model with the appropriate allocation rates.

INVOLUNTARY LOSSES: Involuntary losses are those losses that occur when the soldier is determined to be unqualified to continue in the force. There are two ways this can occur:

Retention Control Points. These are the maximum numbers of years of active federal service authorized for a soldier in a specific grade. The default file will set control points as specified in AR 600-200 for each projection year, however the user may change these control points in anticipation of policy changes.

Qualitative Management Program Losses. These are losses that occur as a result of DA screening boards. The input file accepts anticipated numbers of QMP losses for each projection year by grade as well as a distribution for these losses across YOS.

DISTRIBUTION OF BASELINE INVENTORY BY TIME-TO-ETS: This distribution allows the model to set the baseline inventory across the time-to-ETS dimension. The default data reflects a matrix dimensioned by YOS, time-to-ETS, and subinventory. For each

subinventory the SAS program calculated the percentage of records in each of six time-to-ETS cells defined as 0-12 months to ETS; 13-24 months to ETS; 25-36 months to ETS; 37-48 months to ETS; 49-60 months to ETS; and 61-72 months to ETS. This distribution is automatically set at the beginning of a run and can not be modified by the user.

DISTRIBUTION OF TERM LENGTHS: To keep track of numbers of soldiers as they transition across the time-to-ETS dimension, there are three files of that will distribute initial enlistments, reenlistments, and extensions.

Initial Enlistments. When measuring NPS accessions using the ODCSPER gain/loss tapes, we accumulated accessions by initial term of service. This generated a vector of NPS accessions by term of service and is used as the default data for each projection year in the input file. The user may modify this to reflect anticipated policy changes.

Reenlistments. Using the gain/loss tapes and the EMF for both end FY89 and FY90 we identified reenlistments and then conducted a "crosstabs" comparing time-to-ETS. This generates a matrix dimensioned by old time-to-ETS and new time-to-ETS. The default file reflects this transition matrix for each projection year. The user may adjust the matrix to reflect any anticipated policy changes.

Extensions. In a similar way we used the gain/loss tapes and the EMF for both end FY89 and FY90 we identified extensions and then conducted a "crosstabs" comparing time-to-ETS. This generates a matrix dimensioned by old time-to-ETS and new time-to-ETS. The default file reflects this transition matrix for each projection year. The user may adjust the matrix to reflect any anticipated policy changes.

APPENDIX C

LINKING ACCESSION SUPPLY TO EPICC: DESIGN CONCEPT PAPER

I. Introduction

Given compensation and other personnel policies, the Enlisted Personnel Inventory, Compensation, and Cost (EPICC) Model estimates the number of non-prior service accessions required to meet specified endstrength targets. The EPICC prototype also estimated the cost of obtaining those accessions using a methodology developed for the Army Manpower Cost System (AMCOS). Specifically, the average cost of recruiting a high quality (AFQT categories 1-3A, high school diploma graduate) and a non-high quality soldier, which is calculated from recruiting resources expended in a base year, is applied to the required number of high quality and other accessions to derive total costs.

While this costing approach is adequate for many applications, it ignores the empirical evidence that the average cost of recruiting high quality individuals rises with the high quality recruiting mission. Therefore, accession cost estimates using constant average costs will understate the cost of recruiting more individuals than were accessed in the base year and overstate the costs of recruiting fewer. This is a potentially serious problem when EPICC is used to evaluate significant changes in accession levels, as in analyzing alternatives for downsizing the enlisted force.

This paper describes an alternative approach to estimating accession costs using a cost function. The recruiting cost function describes the *minimum* costs associated with achieving a given recruiting mission specified by quality level. It is derived directly from an enlistment supply function, which describes how recruiting resources, such as advertising and recruiters, and market factors, such as unemployment and the level of military pay, affect the number of high quality enlistments. This approach offers several analytical advantages over the methodology used in the prototype:

- Because the enlistment supply function now used in EPICC displays decreasing marginal returns to recruiting resources, the cost function will generate marginal and, therefore, average costs that rise with the level of accessions. This will improve the estimate of recruiting costs when the level of accessions varies from the base year.

- Because the enlistment supply function includes market factors, accession cost estimates will vary with the assumed

C-1

unemployment rate and level of relative military pay. Thus, the two principal avenues by which the civilian labor market affects enlisted personnel policy -- accession costs and reenlistment rates -- will be incorporated into EPICC projections.

• Because the recruiting cost function calculates the minimum cost of achieving a particular recruiting mission, it implicitly solves for the optimal mix of recruiting resources. Thus, the resource implications of alternative accession missions can be expanded from the current information on total costs to include estimates of the required number of recruiters, the optimal amount of advertising, and the best size for the enlistment bonus pool.

The key parameters of the new cost function are simply enlistment supply elasticities, the percent change in high quality contracts for a percent change in recruiting resources/incentives or market factors. Our implementation of the recruiting cost function in EPICC will allow the analyst to change these elasticities, providing a way for new information on enlistment supply to be easily incorporated into the recruiting cost estimates provided by the model.

Section II of this paper describes the cost function approach in detail. In Section III, we demonstrate the approach using FY90 data. Section IV discusses implementation of the cost function in the EPICC model.

II. A Recruiting Cost Function

Our approach is a direct application of the microeconomic theory of production costs.[1] We derive the recruiting cost function from the enlistment supply function and the prices of recruiting resources using the mathematics of constrained minimization. To begin, we assume that the number of high quality contracts signed in a given time period can be described by an enlistment supply function of the form where

• A_H, A_M and A_L are high quality, "medium"

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[1]Similar methods have been used to determine the recruiting costs of alternative quality distributions for the Navy (Deborah Clay-Mendez, *A Recruiting Cost Function for Male High School Graduates*, Center for Naval Analyses, 1982) and in the OSD Accession Quality Cost-Performance Tradeoff Model currently under development.

$$\ln A_H = \alpha_0 + \alpha_M \ln\!\left(A_M^{max} - A_M\right) + \alpha_L \ln\!\left(A_L^{max} - A_L\right) + \sum_i (\alpha_i \ln R_i)$$
$$+ \sum_j (\alpha_j \ln I_j) + \sum_k (\alpha_k \ln F_k) \qquad (1)$$

quality (AFQT category 1-3A non-graduates), and "low" quality (all others) accessions, respectively;[2]

- R's are recruiting resources, such as the number of recruiters and the amount of advertising;

- I's are recruiting incentives, such as the average enlistment bonus and the average value of the Army College Fund (ACF);[3]

- F's are factors that affect the recruiting market, such as the unemployment rate, and the level of military pay relative to civilian pay; and

- α's and A^{max}'s are parameters of the enlistment supply function.

The form of this enlistment supply function, log-log, is similar to that commonly used in the enlistment studies. The α's represent the elasticity of high quality enlistments with respect to recruiting resources, incentives, and market factors.[4] The only difference is in our treatment of the tradeoff between high quality and other enlistments, which is typically captured by including $\ln(A_M)$ and $\ln(A_L)$ directly, rather than relative to a maximum accession amount. The standard approach, however, implies an improbable tradeoff in which the increase in high quality contracts associated with an decrease in the medium or

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[2]While the high quality definition is standard, "medium" and "low" are our choice of labels for the accession groups defined in parentheses. We use these groupings simply because the associated supply parameters have been estimated in the literature.

[3]In our terminology, recruiting resources are inputs to the recruiting process that have prices attached to them while incentives are benefits paid to high quality recruits.

[4]Equation (1) can also be interpreted as the logarithmic form of a Cobb-Douglas production function, a functional form which places certain restrictions on the substitution of inputs in the production process. In principle, recruiting cost functions can be developed from more flexible production functions. In practice, our empirical knowledge about recruiting production functions is, for the most part, limited to the Cobb-Douglas form.

low quality mission is largest when the number of non-high quality contracts is small, rather than large. In economic terms, the production possibility frontier in equation (1) has the expected convex shape; the standard approach produces a frontier that is concave to the origin.

The minimum costs associated with recruiting a given number of high quality contracts, A_H^*, is given by the answer to the constrained minimization problem

$$\text{Min } \left[\sum_i (p_i R_i) + A_H^* \sum_j I_j \right] - \lambda \left[A_H - A_H^* \right] \tag{2}$$

The first term in brackets represents the variable cost portion of the recruiting budget; it has two components. The first is the sum of expenditures on recruiting resources, determined by multiplying the level of resource use, R_i, by the resource price, p_i. The second shows the expenditures on recruiting incentives, which equals the average cost of these incentives multiplied by the number of high quality contracts. The second term in brackets assures that costs are minimized subject to the constraint of recruiting A_H^* high quality individuals.

The first order conditions for equation (2) describe the solution to the cost minimization problem -- the levels of recruiting resources, R_i^*, and incentives, I_i^*, required to

$$R_i^* = \left(\frac{\alpha_i}{p_i}\right) Z \quad \text{and} \quad I_j^* = \left(\frac{\alpha_j}{A_H}\right) Z$$

where

$$Z = \left[e^{\frac{-\varepsilon_0}{\varepsilon}} \prod_i \left(\frac{\alpha_i}{p_i}\right)^{\frac{-\varepsilon_i}{\varepsilon}} \prod_j \alpha_j^{\frac{-\varepsilon_j}{\varepsilon}} \prod_k F_k^{\frac{-\varepsilon_k}{\varepsilon}}\right] \left(A_M^{max} - A_M\right)^{\frac{-\varepsilon_M}{\varepsilon}} \left(A_L^{max} - A_L\right)^{\frac{-\varepsilon_L}{\varepsilon}} A_H^{\frac{1+\Sigma \varepsilon_j}{\varepsilon}} \tag{3}$$

and $\quad \alpha = \sum_i \alpha_i + \sum_j \alpha_j$

recruit A_H^* at minimum cost.
Substituting these equations for the levels of resources into the cost equation yields a recruiting cost function of the form

$$C_T = \sum_i \left(p_i R_i^*\right) + A_H \sum_j I_j^* + C_F \tag{4}$$

where C_T is total recruiting costs and C_F is the fixed costs associated with recruiting.

This cost function has four conceptual advantages over the methods typically used to estimate recruiting budgets. First, the marginal cost of recruiting a high quality soldier rises with the mission, as implied by enlistment supply research. Unit or average-cost estimation methodologies incorrectly assume constant

Table C-1: Inputs to FY90 Cost Function

Enlistment Supply Elasticities		Resource Prices	
Production recruiters	0.25	Production recruiters	$54,825
Advertising	0.05	Advertising	$1
Enlistment bonus	0.07		
Army College Fund	0.14	Fixed Recruiting Costs	$118M
Unemployment	0.70		
Relative military pay	0.80	FY90 Market Factors	
Constant	1.49	Unemployment rate	5.3%
		Relative military pay	0.89
Quality Tradeoff Parameters		FY90 Contracts	
High-to-medium	1:2	AFQT 1-3A, HSDG	63,100
High-to-low	1:6	AFQT 1-3A, NHSDG	1,100
		AFQT 3B, 4	25,200

marginal costs.[5]

Second, the cost function shows how changes in the recruiting environment will affect the costs of recruiting a given mission. Unemployment, for example, is positively related to high quality enlistments which means that the minimum costs to recruit a given mission will decrease when unemployment increases. Methods based on historical costs alone implicitly assume that the recruiting environment is static.

Third, because costs are based on an optimal allocation of recruiting resources, the cost function is superior to determining changes in recruiting costs by varying only one resource, such as the number of recruiters. In general, these "one resource" approaches will overstate the required change in costs.

Fourth, most recruiting cost estimation methodologies assume that the costs of recruiting a given high quality mission are not affected by the size of non-high quality mission. This contradicts recent enlistment supply research which demonstrates that increasing the non-high quality mission, without increasing the number of recruiters, "crowds out" some high quality production. Because the cost function is based on an enlistment supply function which includes non-high quality enlistments, it recognizes that interaction.

III. An Application to FY90 Recruiting Costs

To validate the methodology, we developed an Army recruiting cost function for FY90. Table 1 lists the values of the parameters and variables in the cost function.

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[5]Formulas for the marginal costs of recruiting high quality and other soldiers are shown in an addendum to this paper.

The supply elasticities are drawn from the following studies:

- Recruiter, advertising, unemployment, and relative pay: Thomas V. Daula and D. Alton Smith, "Estimating Enlistment Supply Models for the U.S. Army," in R. Ehrenberg, ed. *Research in Labor Economics*, Volume 7. Greenwich, CT: JAI Press, 1985.

- Enlistment bonus: J.M. Polich, et al. *The Enlistment Bonus Experiment*. RAND Corporation (R-3353-FMP), 1985.

- Army College Fund: D. Alton Smith et al. *Army College Fund Cost-Effectiveness Study*. SRA Corporation, 1990.

While there is a fairly wide range of supply elasticities in the research literature, these are typical of the findings in the better studies.[6]

The constant, α_0, is calculated so that the enlistment supply function predicts the actual FY90 high quality contracts, given the level of FY90 recruiting resources/incentives and market factors. Choosing the constant this way assures that the cost function is based on a reasonably accurate enlistment supply function when one study cannot provide the best estimate of all required parameters. It does not, however, force the costs predicted for FY90 to equal actual costs, as the Army may not have used the mix of resources estimated to be optimal by the cost function.

The parameters measuring the tradeoff between high quality and other enlistments are set so that in FY90 a reduction in one high quality contract, other factors held constant, yields either two additional medium quality contracts or 6 additional low quality contracts.[7] The available evidence suggests a high-to-

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[6] All of these studies use regression analysis to estimate the supply elasticities. Other approaches to estimating production functions, such as Data Envelopment Analysis (DEA) or frontier production functions, could also be used to provide the supply elasticities for the cost function.

[7] The formula for α_M is

$$\alpha_M = \frac{\Delta A_H}{\Delta A_M}\left(\frac{A_M^{max} - A_M}{A_H}\right)$$

Using a maximum of 25,000 medium quality contracts and setting A_H and A_M at FY90 levels, α_M is 0.23 for a 1:2 tradeoff. Using an analogous formula with a maximum of 75,000 low quality contracts, α_L is 0.12 for a 1:6 tradeoff.

low tradeoff of between 1:4 and 1:8; the high-to-medium tradeoff is simply an extrapolation of these results.[8]

The price information is determined as follows. Advertising is measured in dollar terms, so we set the price to $1. The recruiter price includes both the military compensation and support costs (such as transportation and office expenses) of adding a production recruiter. We calculate it by dividing 85% of field recruiting costs in FY90 by the number of production recruiters. The remaining 15% of field costs are assumed to be fixed management expenses and are included along with headquarters costs in the estimate of fixed recruiting costs.[9]

Table 2 compares the resource levels and recruiting budget predicted from this methodology with the actual numbers.

Table C-2: FY90 Predicted v. Actual Resource Levels and Costs

	Cost Function	FY90 Actual
Resource Levels		
Production recruiters	5,508	5,700
Advertising (variable costs in M$)	46.6	55.6
Enlistment bonus ($ per HQ recruit)	1,035	935
Army College Fund ($ per HQ recruit)	425	272
Recruiting Budget		
Variable costs	$459M	$444M
- ACF costs	18M	0
+ Fixed costs	118M	118M
Total costs	559M	562M

Predicted values are calculated by substituting the values in Table 1 into equations (3) and (4). We include the ACF in determining the minimum budget but subtract its total cost for comparison with the actual budget. In FY90, the accrual charges for the ACF were set at zero to compensate for previous overcharges. Both the enlistment bonus and the ACF value are expressed in dollars per high quality enlistment. Because only a fraction of high quality recruits receive a bonus or ACF benefit,

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[8]See Daula and Smith, *op cit*, and J. Dertouzos, *Recruiter Incentives and Enlistment Supply*. RAND Corporation, R-3065-MIL, 1984.

[9]These cost data were obtained from ODCSPER.

these numbers are smaller than the statutory amounts.[10]

The cost function results imply that a reallocation of
resources away from the recruiters and towards advertising and
the enlistment bonus would have achieved the same mission of high
quality and other enlistments at a slightly lower variable cost.
The difference, however, is relatively small and probably within
the range of measurement error associated with the enlistment
supply elasticities. In general, there is a remarkable
correspondence between the cost function predictions and the
actual budget for FY90.

Table C-3: FY90 Marginal Cost Estimates

Accession Category	Marginal Costs
AFQT 1-3A, high school diploma graduate	$16,185
AFQT 1-3A, non-graduate	7,725
AFQT 3B and 4 (both graduate and non-graduate)	2,575
Recruiting Environment	
Half point increase in unemployment rate	-$66M
Two percentage point increase in relative military pay	-$15M

Table C-3 displays two types of marginal cost estimates that
can be derived from the cost function. The first section shows
the estimated marginal costs of recruiting three different
categories of individuals. High quality recruits, of course,
have the highest marginal costs. Although not shown in the
table, the marginal costs in this example depend upon the
mission. High quality marginal costs, for example, increase with
either the high quality or other mission. Increasing marginal
costs with the high quality mission follows from an upward
sloping supply curve for high quality individuals. Increasing
marginal costs of high quality recruits with increases in the
other missions is an implication of the interaction between
missions in the production function.

The second section displays the estimated budget impacts of
two favorable changes in the recruiting environment -- an
increase in unemployment and an increase in military pay relative
to the private sector. Both changes reduce the cost of
recruiting a given mission.

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[10]The cost of the ACF is less than the benefit level because
benefits are paid in the future and not all eligibles decide to
use their benefits. We multiply the total benefits paid, $A_H I_{ACF}$,
by the ratio of the accrual charge in FY90 ($1,342) to the 3-year
benefit level ($12,000) to estimate ACF costs.

IV. Implementing a Recruiting Cost Function in EPICC

     The recruiting cost function described in the previous two
sections replaced the AMCOS methodology for calculating accession
costs in EPICC. We discuss the implementation in two parts: the
inputs to the cost function and the cost/resource outputs.

     Inputs. Table C-1 organizes the required inputs into six
categories. The inputs in each category will be determined as
follows:

   •   Enlistment supply elasticities. A screen was
        developed displaying the elasticities in
        Table C-1 as default values which, with the
        exception of the constant, can be changed by
        the user. If any of the elasticities are
        changed, EPICC will recalculate the constant
        to assure that the enlistment supply function
        is still accurate for FY90.

   •   Quality tradeoff parameters. The recruiting
        cost screen also allows the analyst to change
        the assumed tradeoff between high quality and
        other recruits. EPICC will automatically
        recalculate the underlying enlistment supply
        function parameters.

   •   Resource prices and fixed recruiting costs.
        Base year values for these prices can be
        changed in the recruiting cost screen. To
        estimate projection year costs in then-year
        dollars, EPICC will inflate the recruiter
        price using the MPA inflation rate,
        advertising using the OMA rate, and fixed
        recruiting costs using an average of the MPA
        and OMA rates.

   •   Market factors. The unemployment and
        relative military pay assumptions by
        projection year are the same as those used in
        the compensation-retention module to adjust
        reenlistment rates.

   •   Contracts. The number of high, medium and
        low quality contracts to be used in
        estimating recruiting costs will be generated
        by the inventory module.

To facilitate the evaluation of alternative supply elasticities,
quality tradeoffs, and resource prices, a pop-up screen accessed
from the primary recruiting cost screen will duplicate the
information in Table 2, showing the optimal resource mix and
costs associated with new parameters for FY90 for comparison with
the actual results.

<u>Outputs.</u>   The cost function will generate the following items for each projection year in an EPICC run:

- Total recruiting costs, by appropriation. Total costs are given by equation (4). We will allocate these costs by appropriation as follows:

    - Advertising: OMA
    - Recruiter costs: MPA and OMA in proportion to base year appropriation shares
    - Enlistment bonus: MPA
    - Army College Fund: MPA
    - Fixed recruiting costs: Base year MPA/OMA shares

- Minimum-cost resource/incentive mix, including the number of production recruiters, the amount of advertising, the average enlistment bonus, and the average value for the ACF.

Addendum: Marginal Recruiting Costs

The marginal cost of a high quality recruit is determined by differentiating equation (4) with respect to A_H,

$$MC_H = (1+\Sigma_j \alpha_j) \left[e^{\frac{-\alpha_0}{\epsilon}} \prod_i \left(\frac{\alpha_i}{p_i} \right)^{\frac{-\alpha_i}{\epsilon}} \prod_j \alpha_j^{\frac{-\alpha_j}{\epsilon}} \prod_k F_k^{\frac{-\alpha_k}{\epsilon}} \right]$$

$$\left(A_M^{max} - A_M \right)^{\frac{-\alpha_M}{\epsilon}} \left(A_L^{max} - A_L \right)^{\frac{-\alpha_L}{\epsilon}} A_H^{\left(\frac{1+\Sigma \alpha_j}{\epsilon} - 1 \right)}$$

Marginal costs rise with the number of high quality contracts if the exponent of A_H is positive, or $(1+\Sigma_j \alpha_j) > (\Sigma_i \alpha_i + \Sigma_j \alpha_j)$. This will be true if the sum of the elasticities on recruiting resources is less than one, a condition which holds for reasonable values of these elasticities.

APPENDIX D

USER'S GUIDE TO MODIFYING PAY LEASTICITIES IN EPICC

As part of the input to the compensation module, EPICC users can modify pay elasticities defined by year of service (YOS) and by quality categories (AFQT I-IIIA high school graduates, AFQT I-IIIA nongraduates, and all others). The compensation module uses these elasticities to calculate the parameters in the compensation-retention equations that relate changes in the annualized cost of leaving (ACOL) to changes in reenlistment rates.

The default pay elasticities included with EPICC are derived from the results of the Army Compensation Models Project (Smith et al.), which studied the reenlistment decisions of enlisted personnel from 1976 through 1987. An important question is whether these estimates are still appropriate for use in projecting the reenlistment effects of compensation policy changes in the 1990's. With the end of the Cold War, and the subsequent reduction in the size of the Army, the characteristics of and opportunities associated with an enlisted career in the Army have changed markedly, potentially affecting the responsiveness of reenlistment decisions to compensation changes. A definitive answer to this question can only be provided through new reenlistment research using recent data.

Until those results are available, however, it is important to understand how the existing elasticities should be modified when evaluating compensation policy changes to reflect the new environment . We offer two insights: one derived from ACOL theory and the other from practical considerations in evaluating personnel policies.

Insight #1: If you believe that soldiers today place a lower value on the nonpecuniary aspects of a military career, as compared with the 1980's, then the pay elasticities in EPICC should be increased.

This insight is derived from ACOL theory. To review, the ACOL decision rule states that a soldier will reenlist if

$$ACOL > (NC-NM) \qquad (1)$$

where *ACOL* is the maximum value (across different military career horizons) of the annualized difference between military and civilian compensation streams and *NC* and *NM* are the annual value of the nonpecuniary characteristics of a civilian and military career, respectively.

The first panel in Figure 1 shows how the decision rule is used to predict the reenlistment rate for a group of soldiers who, because of similar service characteristics, have the same

ACOL. Because we can't explicitly value the nonpecuniary factors in equation (1), we assume that *(NC - NM)* is a random variable distributed according to the triangular distribution shown in Figure D-1. According to the ACOL decision rule, then, the reenlistment rate for these soldiers is the area of the civilian-military "taste" distribution to the left of the ACOL line.

The ACOL parameter in a retention-compensation model measures the change in the reenlistment rate for a given change in ACOL, or the shaded area in each of the panels. In the second and third panels, we have varied the mean of the taste distribution. Because we also keep the shift in ACOL values the same as in the first panel, any change in the shaded area represents a similar change in the ACOL parameter. For example, the taste distribution in the second panel has a smaller mean than that of the first, indicating that the nonpecuniary characteristics of a civilian career are valued *less* on average. The size of the shaded area and, therefore, the ACOL parameter decreases. Conversely, when average military preferences decrease as shown in the third panel, the ACOL parameter and the sensitivity of reenlistments to pay changes increases.
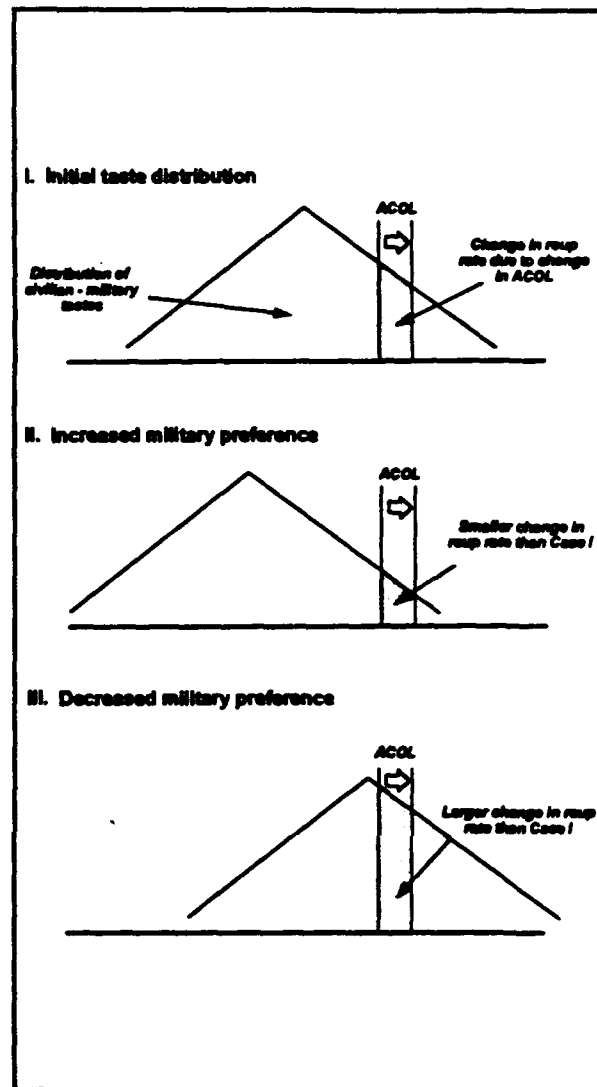

Figure D-1. Taste distribution and the ACOL parameter.

(Differences in the taste distribution explain two common empirical findings about pay elasticities. First, because of self-selection, we would expect preferences for the military to increase with years of service, implying decreasing pay elasticities, which are found by Smith et al. and others. Second, if military and civilian jobs have similar attributes, the variance of the taste distribution will be smaller, increasing the pay elasticity. Confirming this hypothesis, Smith et al. find that first-term pay elasticities for the Mechanical Maintenance and Administration MOSs are larger than those for the Infantry MOSs.)

We can only speculate how differences in the current enlisted career environment would change the taste distribution from that represented in the estimated pay elasticies supplied with the compensation module. It seems, however, that most of the environment changes—reduced nonpay benefits, leaner operating and training budgets, more nontraditional missions, more social diversity—will make the nonpecuniary aspects of a military career *less* attractive. In this case, ACOL theory predicts that today's pay elasticies will be higher than those measured from reenlistment decisions made in the 1980's.

Insight #2: The estimated effect on total reenlistments of a compensation policy change is most sensitive to changes in the pay elasticities for early years of service.

The estimated change in reenlistments for a compensation policy change is given (approximately) by

$$\Delta \, Reenlistments = \sum_{i=1}^{30} (ETS \, Inventory_i) \; x \; (ETS \, Reup \, Rate_i)$$

$$x \; (Percentage \, Change \, Pay_i) \; x \; (Pay \, Elasticity_i)$$

(2)

Equation (2) shows that variation in pay elasticities has the greatest effect on total reenlistments where the ETS inventories and the default reenlistment rates are largest. Inventories decrease with years of service, while reenlistment rates increase. The inventory effect is greater, however, as demonstrated in Table 1. Using selected data from EPICC, it shows the range of additional reenlistments predicted for a 5% pay increase when the default pay elasticity is decreased by 50% from the expected value and increased by 50%. About 60% of the variation between the high and low reenlistment estimates is due to variation in the YOS 2-4 elasticity.

That pay elasticities for the early year of service are most important in estimating voluntary losses also suggests where the research effort should be placed in obtaining new elasticity estimates. Simple ACOL models of first-term reenlistment decisions are not only the easiest to estimate; they will also yield the greatest benefits for policy evaluation.

Table D-1

Variation in Estimated Reenlistments with Elasticity Variation

YOS	ETS Inventory	Reenlistment Rate	High-Low Pay Elasticity	High-low Reenlistments
2 - 4	49,100	.24	.95 - 2.9	1709 - 559 = 1150
6 - 8	19,200	.54	.63 - 1.9	986 - 327 = 659
10 - 12	6,900	.70	.31 - .94	229 - 76 = 153

References

Smith, D. Alton et al. "Army Reenlistment Models," in Curtis L.Gilroy, David K. Horne, and D. Alton Smith, eds. *Military Compensation and Personnel Retention: Models and Evidence.* United States Army Research Institute for the Behavioral and Social Sciences, 1991.